



DEPARTMENT OF THE AIR FORCE
AIR FORCE REAL PROPERTY AGENCY

14 April 2006

AFRPA Western Regional Execution Center
3411 Olson Street
McClellan CA 95652-1003

Mr. John Broderick
California RWQCB, Santa Ana Region
3737 Main Street, Suite 500
Riverside, CA 92501-3339

Dear Mr. Broderick

Re: Revised Corrective Action Work Plan, Building 550, Former March Air Force Base

The Revised Corrective Action Work Plan for building 550 dated April 2006 is attached for your review and comment. Please provide any comments by 17 May 2006. If you are unable to make this date, please let me know so we can plan field activities accordingly. Thank you for your continuing support of our cleanup program. If you have any questions, please do not hesitate to contact me at (916) 643-0830 ext. 228.

Sincerely

A handwritten signature in black ink, reading "Richard V. Solander".

RICHARD V. SOLANDER
BRAC Environmental Coordinator

Attachment:
Revised Corrective Action Work Plan, Bldg 550

cc:
Mr. Calvin Cox, BAH
Mr. Jerry Bingham, AFCEE/ERB (CD)

Contract No. F41624-01-D9008
Task Order No. 2006

**REVISED CORRECTIVE ACTION WORK PLAN
BUILDING 550, FORMER MARCH AFB, CALIFORNIA**

April 2006

PREPARED FOR:

**AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)
ENVIRONMENTAL SERVICES OFFICE
BASE CLOSURE RESTORATION DIVISION
BROOKS CITY-BASE, TX 78235**

PREPARED BY:

**EARTH TECH
1461 EAST COOLEY DRIVE, STE 100
COLTON, CALIFORNIA 92324**

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LIST OF ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
AFCEE	Air Force Center for Environmental Excellence
AFRPA	Air Force Real Property Agency
ARB	Air Reserve Base
AST	aboveground storage tank
bgs	below ground surface
BRAC	Base Realignment and Closure
BTEX	benzene, toluene, ethylbenzene, and total xylenes
C	Celsius
cm ²	centimeters squared
CPT	Cone Penetrometer Test
CoC	chain of custody
DI	deionized
DCA	dichloroethane
°	degree
DP	Direct Push
EPA	Environmental Protection Agency
FID	flame ionization detector
FSP	Field Sampling Plan
GPR	ground-penetrating radar
GPS	Global Positioning System
HASP	health and safety plan
ID	identification
IRP	Installation Restoration Program
lb	pound
MCL	Maximum Contaminant Level
MDL	method detection limit
µg/l	microgram per liter
mg/kg	milligram per kilogram
ml	milliliter
MNA	monitored natural attenuation
MS/MSD	matrix spike/matrix spike duplicate
MTBE	methyl tertiary butyl ether
MW	monitoring well
MWH	Montgomery Watson Harza
NPDES	National Pollutant Discharge Elimination System
PAT	pump and treat
PID	photoionization detector
PRG	Preliminary Remediation Goal
PVC	polyvinyl chloride
QA/QC	Question Answer/Quality Control
QAPP	Quality Assurance Project Plan
RCAWP	Revised Corrective Action Work Plan
RI/FS	Remedial Investigation/Feasibility Study
RL	reporting limit
RWQCB	Regional Water Quality Control Board
SAP	sampling and analysis plan

SDG	sample delivery groups
SOP	standard operating procedure
SVE	soil vapor extraction
TO	Task Order
TPH	total petroleum hydrocarbons
TPHg	total petroleum hydrocarbons reported as gasoline
UST	underground storage tank
UVIF	Ultra Violet Induced Fluorescence
VMP	vapor monitoring point
VOA	volatile organic analysis
VOC	volatile organic compound

1.0 INTRODUCTION

1.1 PROJECT DESCRIPTION

This Revised Corrective Action Work Plan (RCAWP) describes the activities necessary for performing additional assessment and corrective action at Building 550, the base gasoline station, of the former March Air Force Base (AFB). This plan is being prepared by Earth Tech under the direction of the Air Force Center for Environmental Excellence (AFCEE) under Contract No. F41624-01-D-9008, Task Order (TO) 2006. Building 550 is identified by the Regional Water Quality Control Board (RWQCB) (the lead agency at the site) as Case # 083302549T. In 1993, the Defense Base Realignment and Closure (BRAC) Commission recommended that March AFB be realigned. In 1996, the base was divided in two sections: the Airfield, operated as March Air Reserve Base (ARB), and the portion of the base not retained for military use managed by the Air Force Real Property Agency (AFRPA). The latter is being prepared for ownership transfer.

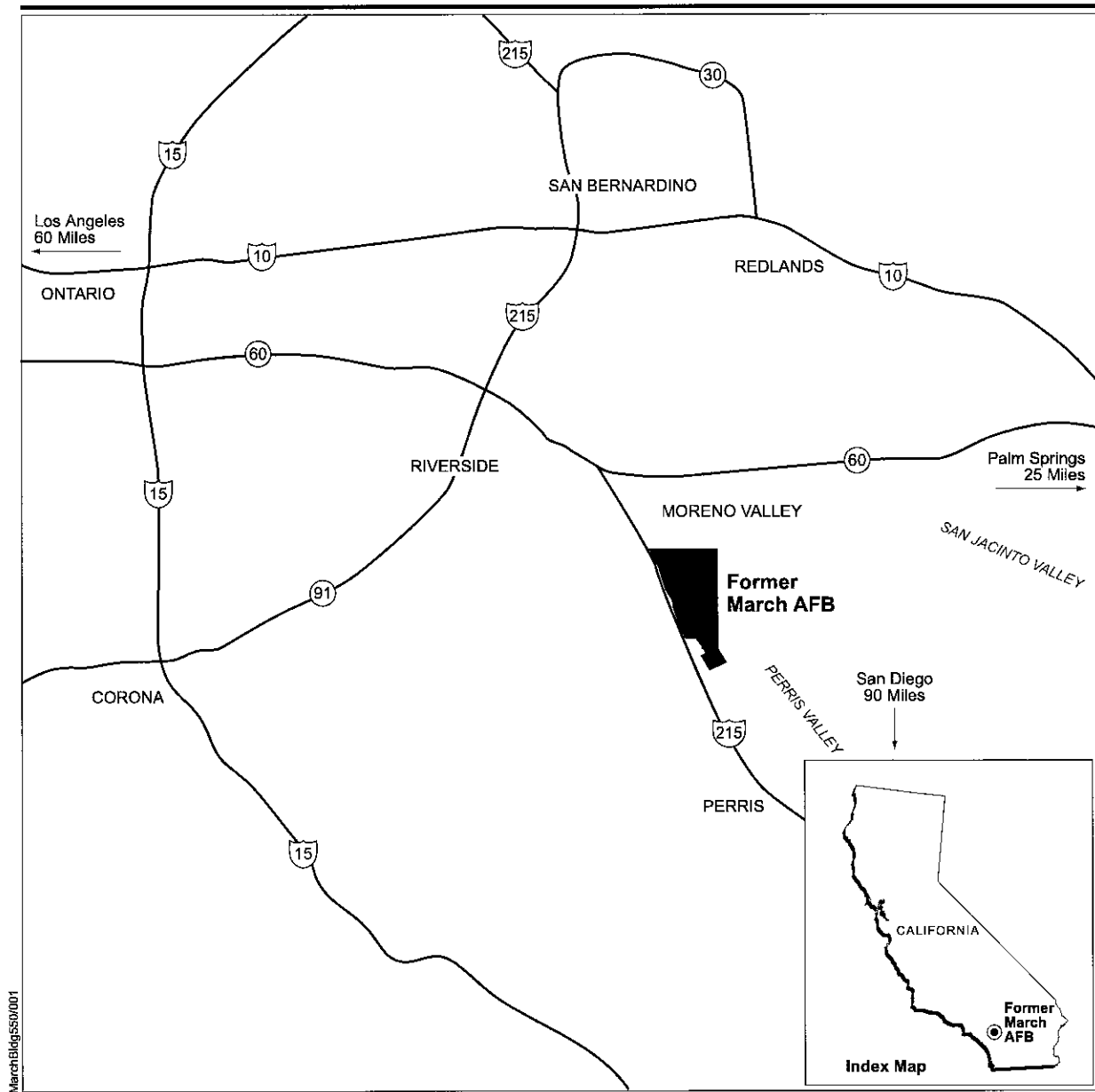
A remedial treatment system for fuels contamination in the soil and groundwater at Building 550 has been in operation since early 2000. The Air Force and the RWQCB both agree that the remedial process at Building 550 has been slow, and that the cost-to-benefit ratio of the remedial system now in place is not at an optimum level. This RCAWP will attempt to address the shortcomings of the system currently in place, and propose a phased alternative.

The fieldwork will be conducted in two parts. Stage One: Further investigation of soil and groundwater to identify the potential source of methyl tertiary butyl ether (MTBE) in the vadose zone near Building 550, and characterize the extent of the MTBE groundwater contamination downgradient of the source area. Stage Two: Installation of additional monitoring and extraction wells, piping from the extraction wells to the treatment system, and revisions to the current treatment systems at the site. These revisions will be based on the results of the Stage One investigation to augment the capture and treatment in the source and downgradient groundwater plume areas.

To implement the activities described in this RCAWP, Earth Tech will provide personnel and equipment, coordination, management, and supervision. Earth Tech will also oversee compliance with contract and regulatory requirements and provide detailed documentation to AFCEE.

1.2 SITE LOCATION AND DESCRIPTION

The former March AFB is approximately 60 miles east of Los Angeles and 5 miles southeast of Riverside, California (Figure 1-1). It is situated along U.S. Interstate Highway 215, which connects the cities of Riverside and San Diego. The former March AFB comprises approximately 2,700 acres of land and is surrounded by the cities of Riverside, Moreno Valley, and Perris, and an unincorporated area of Riverside County to the southwest (Tetra Tech, 1999a).



**Vicinity Map
Former March Air Force
Base**

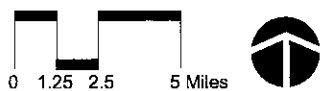


Figure 1-1

1.2.1 Site Background

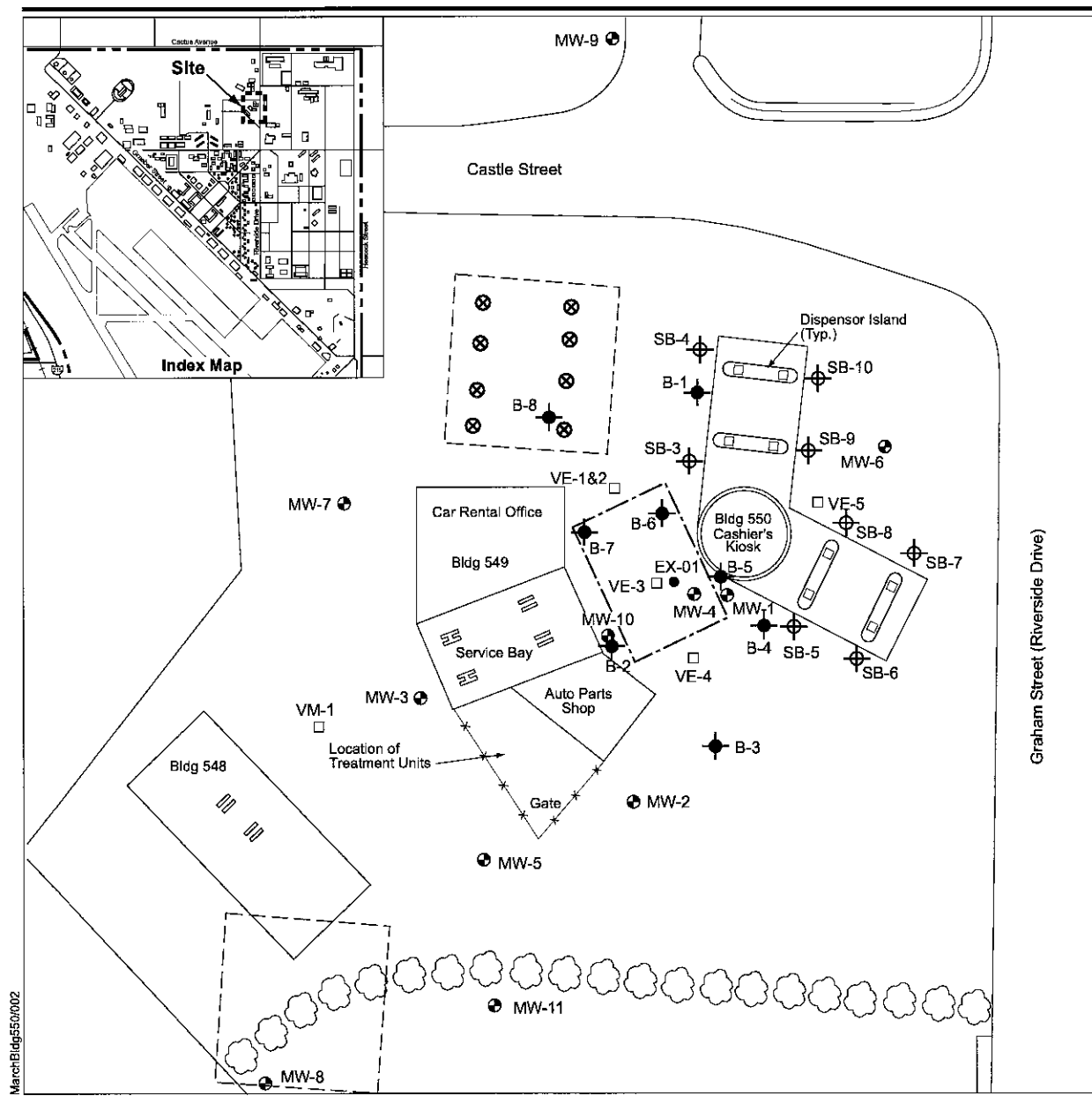
Building 550 is an abandoned gas station on the southwest corner of the intersection of Riverside Drive and Castle Street (Figure 1-2) at the former March AFB. Though the site is designated as Building 550, Buildings 548 and 549 are included within the site. Building 550 is a circular building and is the former cashier's kiosk and associated pump islands; Building 549 contains the former car rental office, service bays, and auto parts store; and Building 548 located at the southwest portion of the site contains additional former service bays. The site is paved and contains entry and exit drives, and parking areas.

Previously the site contained four 10,000-gallon underground storage tanks (USTs) for leaded and unleaded motor fuels, and one 500-gallon UST for waste oil storage (see Figure 1-2). In 1990, repairs were performed on the fuel USTs after testing indicated that leaks were present in the tank hardware. The USTs and associated piping were all removed in 1994 (CKY, 1997). Upon removal, the USTs were found to be in good condition with no observed holes or rusting. Discolored soil and a strong hydrocarbon odor were noted during tank removal activities. The depth of excavation was approximately 12 feet below grade. A total of 10 confirmation samples were collected from the bottom of the excavation, and ranged in depth from 14 to 18 feet below ground surface (bgs). The highest results of contamination were reported beneath the two most southern tanks. None of the contaminated soil from beneath the tanks was removed. The excavation was backfilled with soil from the excavation for the new tank installation located to the north.

Simultaneously with the removal of the old tanks, four new USTs equipped with a leak detection system were installed for automotive fueling along with a new aboveground storage tank (AST) for waste oil storage. The replacement tank storage facilities were located north of the old UST area (see Figure 1-2). These replacement tanks were subsequently removed when the station was closed in mid-1996 (Tetra Tech, 2002). Confirmation samples were collected beneath the replacement USTs and along the piping to the fill pumps. Fuel contamination was found in soil along the piping.

Several investigations conducted from 1996 through 1999 were undertaken in order to define the extent of fuel contamination from gasoline station operations (CKY, 1997; Tetra Tech, 1999a and 1999b). During these investigations, a total of 18 soil borings were advanced and soil samples collected were analyzed for various fuel-related contaminants. Analytical results indicated soil contamination of fuel-related compounds, including total petroleum hydrocarbons (TPH) reported as gasoline; benzene, toluene, ethylbenzene, and total xylenes (BTEX); as well as other volatile organic compounds (VOCs), including MTBE. Investigation results identified that the greatest contamination in the soil was present at the south end of the old UST excavation and around the gasoline pump island to the southeast.

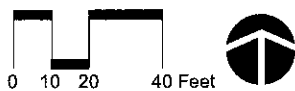
In addition, 11 groundwater monitoring wells (550MW01 through 550MW11) were installed to provide groundwater sampling and tracking of groundwater movement. Groundwater contamination was found beneath the old USTs,



EXPLANATION

- SVE Well
- Groundwater Extraction Well
- ⊕ Monitoring Well
- ⊙ Soil Boring (1999)
- ⊗ Confirmation Sample Location (2001)
- ⊕ Soil Boring (1996)

- Approx. Location of Replacement Tanks
- Approx. Location of Original USTs



Site Map Building 550 Former March Air Force Base, California

Figure 1-2

particularly in the southeast corner of the old tank excavation, and had migrated off site in a downgradient south/southwesterly direction. Analytical results of groundwater samples indicated that BTEX, TPHg, fuel oxygenate MTBE, and VOCs, including 1,2-dichloroethane (1,2-DCA) were present beneath the site (CKY, 1997). In 2004, three additional groundwater monitoring wells (550MW12, 550MW13, and 550MW14) were installed in locations cross-gradient and downgradient to better define the growing MTBE plume. The monitoring wells are shown on Figure 1-3. Well construction diagrams and borehole logs have been included in Appendix A.

1.2.2 Treatment Systems

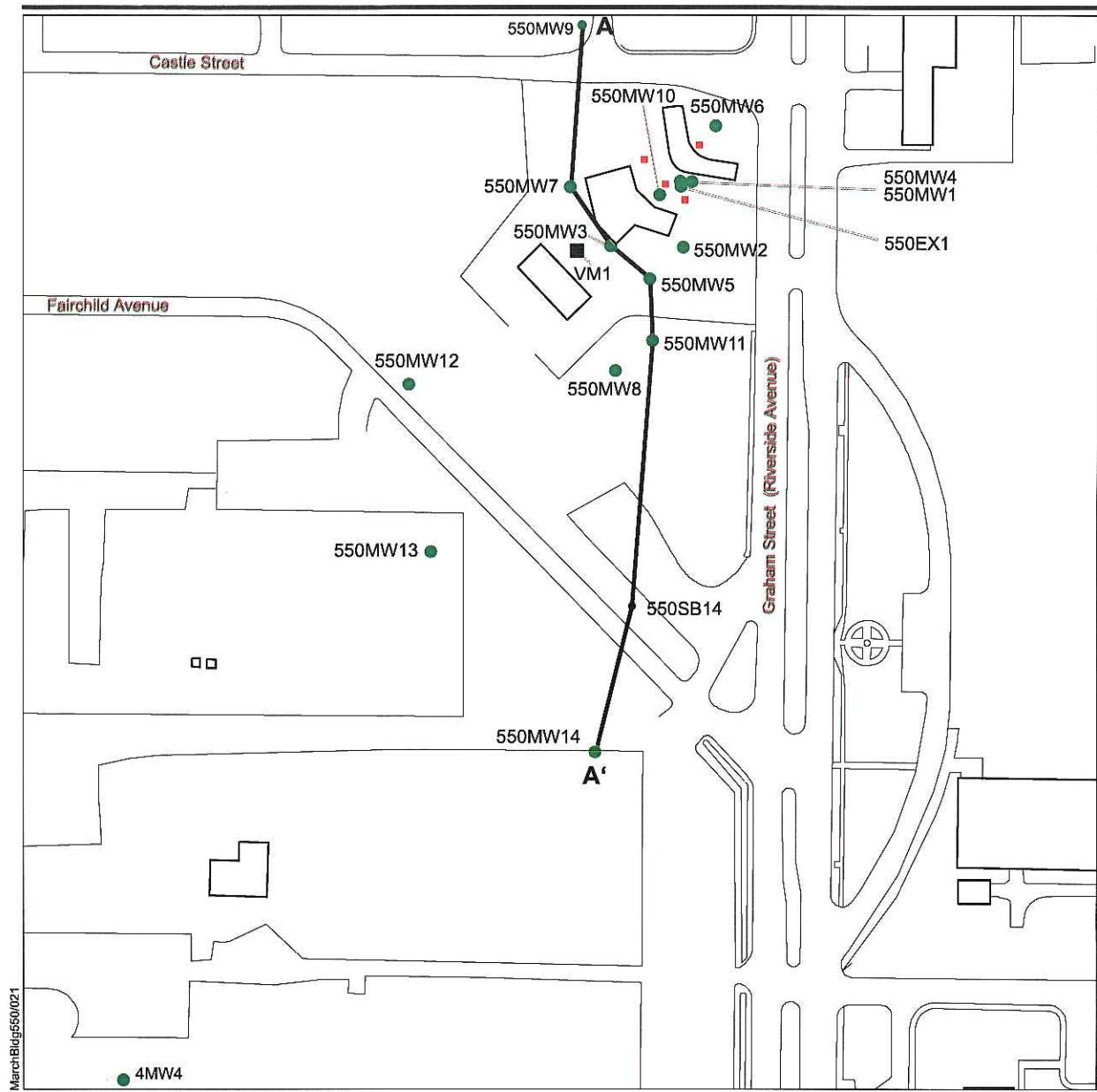
A remedial treatment facility for treating vadose zone soil gas and groundwater was constructed on the site in accordance with the *Draft Final Work Plan Addendum Groundwater Treatment Pilot Study Operable Unit 2, Building 550 March Air Force Base, California* (Tetra Tech, 2001). A total of four soil vapor extraction (SVE) wells were installed in and around the older UST excavation. One soil vapor monitoring point (VMP) was also installed as shown on Figure 1-3. One of the SVE wells was dual completed with screens set at both a shallow and deeper horizon.

The SVE system was placed into operation in February 2000. The SVE system operation was discontinued in April 2003 because the contaminant level in soil vapor from the well field declined to very low levels. This was due in part to a reduction in the total amount of contamination present, the low permeability found in the subsurface limiting the area of influence of the SVE wells, and more importantly, the steadily increasing groundwater level reducing the exposed area of the vadose zone available for soil gas flow. It is likely that the groundwater level rise encroached on contaminated areas in the soil and resulted in at least some of the contaminants being carried downgradient by groundwater flow. During the time of its operation, the total amount of fuel-related contaminants removed and destroyed is estimated to be approximately 2,814 pounds (lbs) (Earth Tech, 2006).

A groundwater pump-and-treat (PAT) system was placed into operation during March 2002. The groundwater treatment system is currently being operated on a continuous schedule. A total of 2 groundwater extraction wells (550EX01 and 550MW10) pump at the combined rate of approximately 0.54 gallon per minute. Since system start-up, approximately 842,000 gallons of water have been treated, and the combined contaminant removed to date is approximately 300 pounds (Earth Tech, 2006). The performance of this system, like the SVE system, is limited by restricted groundwater flow due to low permeability soil associated with sediments beneath Building 550.

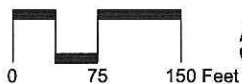
1.2.3 Geology and Hydrogeology

Soils beneath the Building 550 area are dominated by tight, stiff, sandy silts and silty sands. There are some coarser-grained strata with grain sizes ranging from fine to coarse sand. A geologic cross section of the site and extended plume is presented in Figure 1-4. In 1989 prior to initiating groundwater treatment, the



EXPLANATION

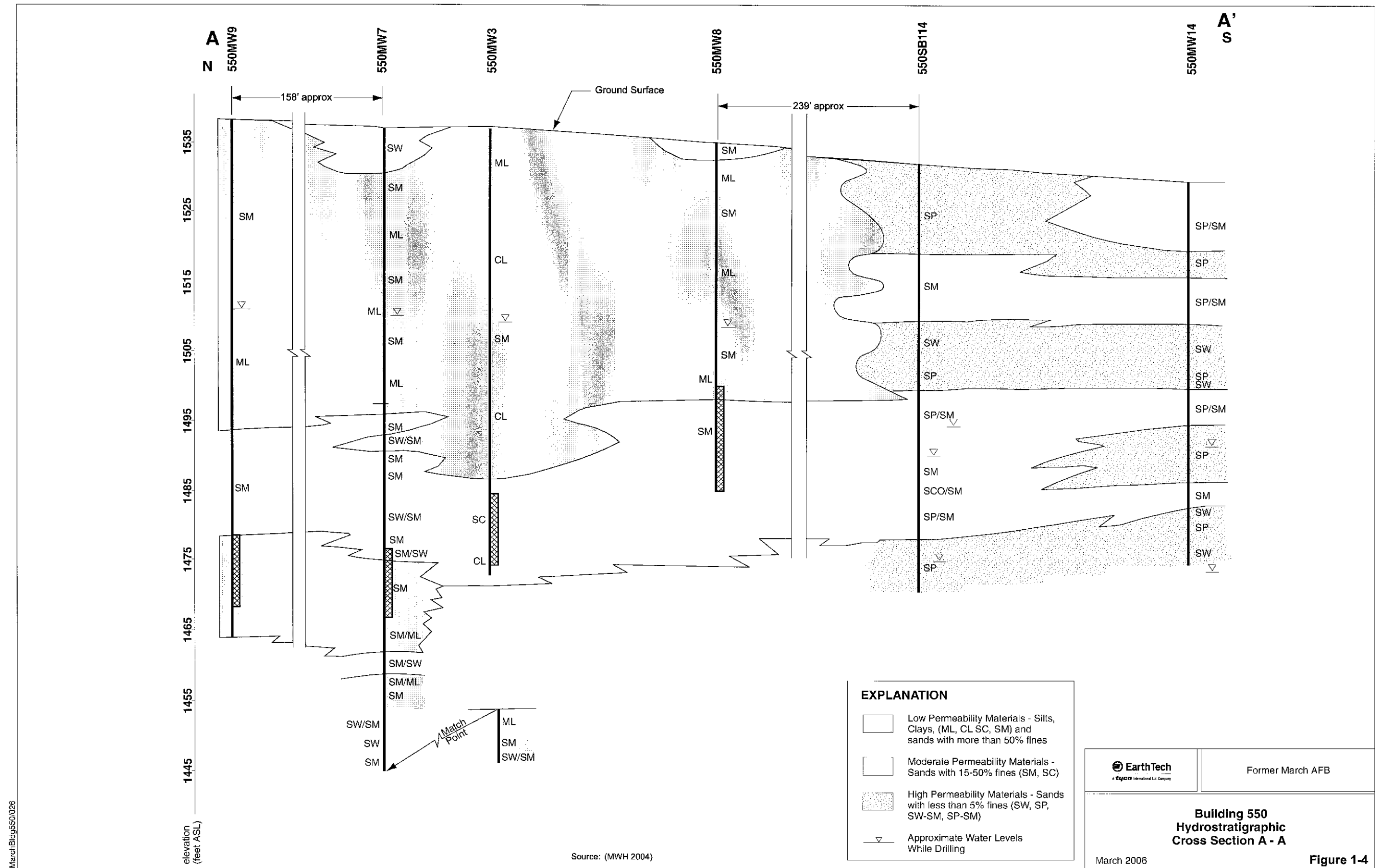
- Monitoring Wells
- SVE Wells
- Roads
- Buildings
- A—A' Cross Section Line
- Vacuum Monitoring Point



Source: (MWH 2004)

Building 550 Monitoring Wells Former March Air Force Base, California

Figure 1-3



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depth to groundwater at the site was measured between 40 to 45 feet bgs. Since then it has risen to approximately 23 feet bgs. The current levels are based on February 2005 water level measurements (MWH, 2005). Groundwater elevations have risen an average of 2 feet per year since 1997 to its current level (MWH, 2004).

1.3 NATURE AND EXTENT OF CONTAMINATION

1.3.1 Soil Contamination

Figure 1-5 shows the lateral extents of measured vadose zone contamination and presents the laboratory results reported from previous soil investigations. All laboratory results that exceed the U.S. Environmental Protection Agency (EPA) Residential Preliminary Remediation Goals (PRGs) are highlighted in bold face text. The known lateral extent of BTEX-contaminated soil begins near the southeastern fuel dispensing island and extends west past the southern edge of the former tank. The BTEX contamination extends northeast beyond the station's dispensing islands and northwest into the former replacement tank excavation area.

BTEX

Analytical results from soil samples collected beneath the former fuel tanks between 14-18 feet bgs during the original UST removal and subsequent soil boring activities indicated benzene concentrations as high as 250 milligrams per kilogram (mg/kg), toluene as high as 680 mg/kg, ethylbenzene as high as 200 mg/kg, xylene as high as 1,200 mg/kg, and TPHg as high as 16,000 mg/kg.

Elevated concentrations of BTEX were reported in boreholes SB-7 and SB-8 near the dispenser islands from 5 to 40 feet bgs. However, results from boreholes B5 (between the cashier's kiosk and the original underground tank pit), SB5, and SB6 south of the fuel dispenser islands reported no concentrations of BTEX from surface down to 35 feet bgs. BTEX concentrations were reported in Borehole B5 from 40 to 50 feet bgs along the water table smear zone. The contamination in shallow soil near SB7 and SB8 indicates a main source of BTEX contamination in soil originated from a possible supply pipe leak beneath the dispensing islands east of the cashier's kiosk in addition to spillage from the original USTs. Soil samples collected in the boreholes near the former tank pit and northern pump dispenser islands reported only minor concentrations of BTEX. The escaped fuels have migrated through the vadose zone in several areas and have affected the groundwater in the saturated zone, as evidenced by groundwater sampled below the former tank locations, as well as from downgradient groundwater monitoring wells.

MTBE

Analytical results from soil samples collected during the soil investigation activities indicated MTBE concentrations ranging from .003 mg/kg to as high as 45 mg/kg. The sole MTBE concentration reported above the PRG (32 mg/kg) was reported in Borehole B8 at a shallow depth of 15 feet bgs. MTBE

concentrations in soil were reported at shallow depths (5 to 15 feet bgs) in boreholes B1, SB3, SB4, and SB9 near the fuel dispenser islands and boreholes SB2, B7, and B8 north of the original UST location. Concentrations of MTBE were reported in 6 boreholes from 20 feet down to 40 feet bgs and in boreholes B-5 and MW1 from 45 down to 55 feet in 1996. The source of MTBE in soil appears to be centered near the replacement USTs and piping to the north of Building 549. The source seems likely to be around 15 feet and radiates laterally and vertically downward. The lateral extent of MTBE-contaminated soil begins near the northern edge of the replacement UST location and extends past the southern part of the former tank excavation, east past the stations northern fuel dispensing island, and west beyond the stations service bays as shown on Figure 1-5.

The MTBE in soil near the eastern fuel dispenser island may have been masked by elevated BTEX concentrations in Borehole SB7 and Borehole SB8 in the past. The primary source of MTBE may be located nearer to the replacement UST location as evidenced by the shallow detections around boreholes B1, SB7, and B8. The high MTBE groundwater concentration in Monitoring Well (MW) 550/MW03 cross-gradient to the original USTs yet downgradient to the replacement tanks also suggests a source near the eastern fuel dispenser or replacement USTs.

1.3.2 Groundwater Contamination

Previous investigations indicated that fuel contaminants migrated through the vadose zone and impacted the groundwater at Building 550. Groundwater sampled during initial characterizations was found to contain TPH, BTEX, and MTBE at significant levels. Other contaminants of concern, including 1,2-DCA, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, and naphthalene (all fuel additives), were also reported in lesser concentrations.

Previous groundwater sampling was performed by Montgomery Watson Harza (MWH) from 12 associated MWs in June 2004. BTEX concentrations were reported in groundwater above MCLs in five wells near the original former UST. The maximum concentrations were reported as benzene 2,600 micrograms per liter (µg/l), toluene 2,000 µg/l, ethylbenzene 1,506 µg/l, and total xylenes (m,p-xylenes, and o-xylenes) 3,700 µg/l. The results of this groundwater sampling have been combined with historical results from each well and are presented on Table 1-1. All concentrations reported above the established MCL for each compound, have been highlighted in bold font.

Figure 1-6 shows the estimated extent of the BTEX contaminant plume. The plume is centered beneath the original former USTs as defined by MWs 550EX01, 550MW01, 550MW02, 550MW03, and 550MW10. A concentration trend analysis for all monitoring wells at Building 550 reported decreasing trends for all BTEX compounds (MWH, 2004), and movement of the BTEX plumes appears to be negligible.

Figure 1-7 shows the estimated extent of the 1,2-DCA contaminant plume. The plume's maximum concentrations are centered around MW 550MW03 behind

Estimated Lateral Extent of Subsurface Soil Contamination Building 550 Former March Air Force Base, California

EXPLANATION

- Soil Boring Location
- ⊕ Groundwater Monitoring Well

Contaminant Concentrations above
Preliminary Remediation Goals (PRG)
are bolded

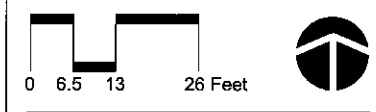
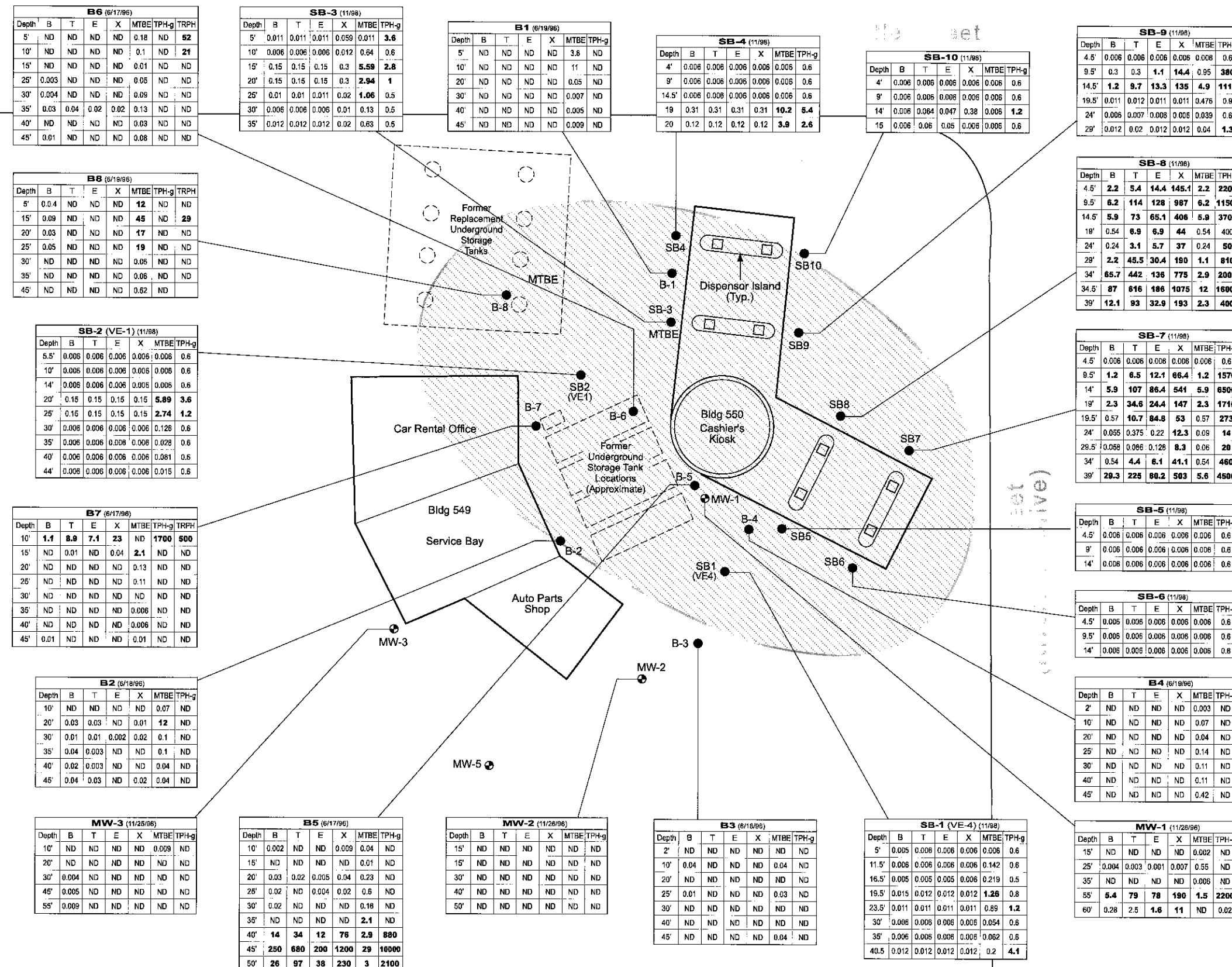


Figure 1-5

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Table 1-1. Historic Monitoring Well Groundwater Results Building 550 Former March Air Force Base
(Page 1 of 5)

		Volatile Organics												
Well Number	Date	Benzene (µg/L)	Chlorobenzene (µg/L)	1,1-DCA (µg/L)	1,2-DCA (µg/L)	cis-1,2-DCE (µg/L)	Ethylbenzene (µg/L)	Ethylene Dibromide (µg/L)	MTBE (µg/L)	Methylene Chloride (µg/L)	Toluene (µg/L)	1,2,4-TCB (µg/L)	Total Xylenes (µg/L)	
MCL ^(a)		1	70	5	0.5	6	300	0.05	13	5	150	5	1,750	
550EX01	01/31/02	10,000	<5.0	<5.0	<5.0	<5.0	792		4,280	8.0	9,490		5,470	
	03/04/02	18,000 D	<1.0	<1.0	<0.50	<1.0	940 D	<1.0	13,000 D	<10	20,000 D	<1.0	10,300	
	03/05/02	8,500	<100	<100	<50	<100	650	<100	2,700	<1,000	7,200	<100	4,800	
	03/06/02	17,000 D	<100	<100	<50	<100	1,500	<100	11,000	<1,000	18,000 D	<100	13,100	
	03/07/02	18,000	<250	<250	<130	<250	1,700	<250	11,000	<2,500	22,000	<250	12,000	
	03/08/02	20,000	<200	<200	<100	<200	1,900	<200	10,000	<2,000	24,000	<200	14,000	
	03/15/02	19,000	<100	<100	<50	<100	2,100	<100	9,600	<1,000	20,000 D	<100	14,600	
	03/22/02	9,500	<200	<200	<100	<200	770	<200	3,400	<2,000	9,700	<200	5,600	
	03/29/02	11,000	<200	<200	<100	<200	1,300	<200	3,900	<2,000	13,000	<200	8,300	
	04/11/02	15,000	<200	<200	<100	<200	1,700	<200	8,000	<2,000	18,000	<200	12,700	
	04/25/02	9,700 D	<1.0	<1.0	<0.50	<1.0	970 D	<1.0	3,900 D	<10	11,000 D	<1.0	7,200	
	05/30/02	7,900	<100	<100	<50	<100	830	<100	3,000	<1,000	9,000	<100	5,800	
	06/27/02	8,900	<100	<100	250	<100	990	<100	3,500	<1,000	10,000	<100	6,000	
	07/25/02	9,500	<100	<100	<50	<100	1,100	<100	3,700	<1,000	12,000	<100	8,400	
	10/08/02	10,000	<100	<100	<50	<100	1,300	<100	5,800	<1,000	13,000	<100	9,400	
	01/28/2003 ^(b)	8,400/8,700	<500/<500	<500/<500	<500/<500	<500/<500	1,100/1,200	<500/<500	4,200/4,600	<500/<500	12,000/12,000	<500/<500	7,400/7,800	
	03/13/03	3,200	<62	<62	<62	<62	300	<62	880	<62	1,100	<62	1,890	
	03/31/03	8,700	<500	<500	<500	<500	890	<500	4,300	<500	13,000	<500	7,900	
	04/24/03	7,200	<250	<250	<250	<250	1,000	<250	3,500	<250	11,000	<250	7,200	
	05/27/03	2,300	<50	<50	<50	<50	280	<50	550	<50	2,600	<50	2,210	
	06/23/03	3,300	<120	<120	<120	<120	470	<120	1,000	<120	4,400	<120	3,600	
	07/28/03	610	<12	<12	45	<12	50	<12	32	<12	250	<12	310	
	08/26/2003 ^(b)	3,300/4,000	<100/<120	<100/<120	<100/<120	<100/<120	410/550	<100/<120	1,300 (J)/2,100 (J)	<100/<120	4,500 (J)/6,300 (J)	<100/<120	3,400 (J)/4,700 (J)	
	09/26/03	2,500	<100	<100	<100	<100	350	<100	920	<100	3,300	<100	2,770	
	10/21/03	2,000	<100	<100	<100	<100	180	<100	620	66 J	2,100	<100	1,860	
	11/25/03	2,100	<33	<33	<33	<33	270	<33	980	<33	2,300	<33	2,550	
	12/22/03	640	<17	<17 (M)	45 (M)	<17	47	<17	68	<17	280	<17	360 (M)	
	01/22/2004 ^(b)	2,700 (J)/580 (J)	<50/<12	<50/<12	<50/<12	<50/<12	310 (J)/76 (J)	<50/<12	190/210	<50/<12	1,800 (J)/620 (J)	<50/<12	2,340 (J)/650 (J)	
	02/27/04	2,200	<100	<100	<100	<100	380	<100	1,000	<100	3,400	<100	2,870	
	04/13/04	2,600	<50	<50	<50	<50	200	<50	1,300	<50	2,000	<50	2,890	
	07/27/04	2,200	<50	<50	<50	<50	230	<50	950	<50	1,600	<50	1,800	
	10/26/04	2,600	<33	<33	<33	<33	220	<33	1,100	<33	1,400	<33	2,650	
	01/26/2005 ^(b)	2,600/2,500	<50/<50	<50/<50	<50/<50	<50/<50	280/280	<50/<50	1,200/1,200	<50/<50	1,000/1,100	<50/<50	2,900/2,900	
	04/27/05	2,400	<25	<25	<25	<25	170	<25	1,200	<25	1,200	<25	2,300	
	08/08/05	1,900	<25	<25	<25	<25	66	<25	740	<25	390	<25	960	
	11/02/05	2,200	<40	<40	86	<40	75	<40	760	<40	240	17 J	1,200	
	02/01/06	1,300	<20	<20	<20	<20	15 J	<20	700	<20	160	<20	570	
	550MW01	03/15/97	11,000	<0.30	<0.30	79	<0.20	890			130	16,000		6,300
		06/15/97	7,200	<0.50	<0.50	77	<0.50	420		740	<1.0	6,100		2,510
		03/15/98	14,000	<0.50	<0.50	<0.50	<0.50	870		4,100	<1.0	18,000		5,000
06/15/98		12,000	<0.50	<0.50	380	<0.50	1,500		2,800	<1.0	20,000		8,100	
09/15/98		12,000	<0.50	<0.50	<0.50	<0.50	1,400		<5.0	<1.0	19,000		6,600	
12/15/98		6,500	<0.50	<0.50	<0.50	<0.50	790		1,400	<1.0	12,000		3,500	
05/05/00		5,290	<0.090	<0.056	<0.065	<0.043	500		1,000	<1.0	6,770		2,500	
06/13/01		8,600	<40 U	<40 U	220	<50 U	1,400		690		11,000		6,800	
12/11/01		4,600	<40 U	<40 U	<50 U	<50 U	1,500		<50 U		5,400		8,000	
07/12/02		1,600	<40 U	<40 U	<50 U	<50 U	1,400		<50 U		3,700		7,500	
09/09/02		1,400	<40 U	<40 U	<50 U	<50 U	660		<50 U		2,300		2,790	
12/02/02		1,900	<2.0 U	<2.0 U	<2.5 U	<2.5 U	1,600		150		3,400		7,100	
04/10/03		890.3 M	<2.5 U	<5.0 U	<2.5 M	<5.0 U	1,078 M	<5.0 U	<25 U	<5.0 U	1,342 M	<5.0 U	3,645.7	
06/24/03		937.9	<5.0 U	<10 U	<5.0 U	<10 U	1,506	<10 U	24.91 J	<10 U	2,322	<10 U	6,229	
08/25/2003 ^(b)		248/239	<5.0 U/<5.0 U	<10 U/<10 U	7.9/7.7	<10 U/<10 U	571/499	<10 U/<10 U	<50 U/<50 U	<30 F/<30 F	335/325	<10 U/<10 U	933/874	

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Table 1-1. Historic Monitoring Well Groundwater Results Building 550 Former March Air Force Base
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		Volatile Organics											
Well Number	Date	Benzene (µg/L)	Chlorobenzene (µg/L)	1,1-DCA (µg/L)	1,2-DCA (µg/L)	cis-1,2-DCE (µg/L)	Ethylbenzene (µg/L)	Ethylene Dibromide (µg/L)	MTBE (µg/L)	Methylene Chloride (µg/L)	Toluene (µg/L)	1,2,4-TCB (µg/L)	Total Xylenes (µg/L)
MCL ^(a)		1	70	5	0.5	6	300	0.05	13	5	150	5	1,750
	12/02/03	220	<25 U	<50 U	<25 U	<50 U	897	<50 U	<250 U	<150 U	841	<50 U	3,632
	06/28/04	358	<5.0 U	<10 U	12	<10 U	913	<10 U	<50 U	8.3 J	490	<10 U	2,939
	09/01/05	130	<20	<20	<20	<20	800	<20	<20	<20	190	<20	2,600
	12/02/05	180 (M)	<17	<17	<17	<17	760	<17	<17	<17	110	<17	2,000
550MW02	03/15/97	29	<0.30	<0.30	43	<0.20	<0.25			<1.0	0.50		0.30 J
	06/15/97	1.5	<0.50	<0.50	36	<0.50	<0.50		190	<1.0	<0.50		<1.0
	09/15/97	<0.50	<0.50	<0.50	34	<0.50	<0.50		160	<1.0	0.74		<1.0
	03/15/98	3.4	<0.50	<0.50	62	<0.50	0.13 J		1,300	<1.0	0.47 J		0.307 J
	06/15/98	<0.50	<0.50	<0.50	58	<0.50	<0.50		500	<1.0	<0.50		<1.0
	09/15/98	1.9	<0.50	<0.50	50	<0.50	<0.50		260	<1.0	<0.50		<1.0
	12/15/98	<0.50	<0.50	<0.50	40	<0.50	<0.50		280	<1.0	<0.50		<1.0
	06/25/01	5.1	8.7	<0.40 U	17	0.79	0.81		170		0.26 J		2.02
	12/12/2001 ^(b)	110/100	<0.40 U/<0.40 U	<0.40 U/<0.40 U	24/24	<0.50 U/<0.50 U	9.1/9.3		850/770		5.5/5.1		12.7/12
	07/11/02	<0.97	<0.40 U	<0.40 U	12	<0.50 U	<0.60 J		170		<1.1 J		<1.0
	09/09/02	8.0	<0.40 U	<0.40 U	8.1	<0.50 U	9.2		200		6.4		15.4
	12/02/02	<0.40 U	<0.40 U	<0.40 U	7.6	<0.50 U	<0.60 U		140		<1.1 U		<1.0
	04/10/03	0.62	<0.50 U	<1.0 U	10.68	<1.0 U	0.34 J	<1.0 U	159	<1.0 U	0.13 J	<1.0 U	0.15 J
	05/23/2003 ^(b)	7.6/8.2	<0.50 U/<0.50 U	<1.0 U/<1.0 U	13/15	<1.0 U/<1.0 U	2.8/3.0	<1.0 U/<1.0 U	250/250	<1.0 F/<1.0 F	0.89 J/0.89 J	<1.0 U/<1.0 U	2.97/3.1
	08/25/03	0.80	<0.50 U	<1.0 U	10.1	<1.0 U	13.7	<1.0 U	297	<3.0 F	<1.0 U	<1.0 U	<2.0
	11/14/03	<0.40 U	<0.50 U	<1.0 U	9.7	<1.0 U	<1.0 U	<1.0 U	186	<3.0 U	<1.0 U	<1.0 U	<2.0
	06/25/2004 ^(b)	1.2/1.3	<0.50 U/<0.50 U	<1.0 U/<1.0 U	5.2/5.4	<1.0 U/<1.0 U	0.47 J/0.51 J	<1.0 U/<1.0 U	89.7/103	<3.0 U/<3.0 U	<1.0 U/<1.0 U	<1.0 U/<1.0 U	<2.0/<2.0
	09/01/05	<1.0	<1.0	<1.0	3.5	<1.0	1.2	<1.0	78	<1.0	<1.0	<1.0	<3.0
	12/02/2005 ^(b)	1.1/0.73 J	<1.0/<1.0	<1.0/<1.0	3.3/3.6	<1.0/<1.0	1.1/0.93 J	<1.0/<1.0	71/84	<1.0/<1.0	<1.0/<1.0	<1.0/<1.0	<3.0/<3.0
	550MW03	03/15/97	85	<0.30	0.20 J	53	<0.20	22			7.9	1.4	
06/15/97		60	<0.50	<0.50	43	<0.50	<0.50		27	7.5	<0.50		<1.0
09/15/97		79	<0.50	<0.50	<0.50	<0.50	<0.50		140	11	0.83		2.2
03/15/98		35	<0.50	<0.50	58	<0.50	<0.50		970	8.9	0.38 J		0.79 J
06/15/98		8.9	<0.50	<0.50	32	<0.50	<0.50		360	<1.0	<0.50		<1.0
09/15/98		23	<0.50	<0.50	59	<0.50	<0.50		780	1.0	<0.50		<1.0
12/15/98		<0.50	<0.50	<0.50	<0.50	<0.50	<0.50		17	<1.0	<0.50		<1.0
07/31/01		<0.40 U	<0.40 U	<0.40 U	22	<0.50 U	0.47 J		4,400		<1.1 U		4.3
12/12/01		3.7	<0.40 U	<0.40 U	21	<0.50 U	<1.4		5,500		<3.9		<5.2
07/12/02		<20 U	<20 U	<20 U	25 J	<25 U	<30 U		4,400		<55 U		<50
12/02/02		<0.40 U	<0.40 U	<0.40 U	23	<0.50 U	<0.60 U		3,300		<1.1 U		<1.0
06/24/03		<4.0 U	<5.0 U	<10 U	19.34	<10 U	<10 U	<10 U	2,599 M	<10 U	<10 U	<10 U	<20
12/02/2003 ^(b)		<0.40 U/<0.40 U	1.4/1.5	<1.0 U/<1.0 U	24.5/23.4	5.2/5.2	<1.0 U/<1.0 U	<1.0 U/<1.0 U	1,370/1,440	<3.0 U/<3.0 U	<1.0 U/<1.0 U	<1.0 U/<1.0 U	0.88 J/0.93 J
06/28/04		19.5 J	<25 U	<50 U	23 J	<50 U	<50 U	<50 U	2,300	69.5 J	<50 U	<50 U	<100
09/01/2005 ^(b)		<12/<25	<12/<25	<12/<25	18/21 J	<12/<25	<12/<25	<12/<25	880/1,000	<12/<25	<12/<25	<12/<25	<38/<75
12/02/05		<12	<12	<12	21	<12	<12	<12	800	<12	<12	<12	<38
550MW04	06/15/99												
	09/09/99	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50		<0.25	<1.0	<0.50		<1.0
	11/11/99												
	03/14/00	<0.054	<0.090	<0.056	<0.065	<0.043	<0.088		<0.097	0.90	<0.034		<0.22
	05/03/00	<0.054	<0.090	<0.056	<0.065	<0.043	<0.088		<0.097	<1.0	<0.034		<0.22
	07/31/2001 ^(b)	<0.40 U/<0.40 U	<0.40 U/<0.40 U	<0.40 U/<0.40 U	<0.50 U/<0.50 U	<0.50 U/<0.50 U	<0.60 U/<0.60 U		0.65/0.29 J		<1.1 U/<1.1 U		<1.0/<1.0
	12/12/01	<1.2	<0.40 U	<0.40 U	<0.50 U	<0.50 U	<0.60 J		<0.50 U		<1.6		<2.1
	07/10/02	<0.71	<0.40 U	<0.40 U	<0.50 U	<0.50 U	<0.60 J		<0.50 U		<1.1 J		<1.5
	11/26/02	<0.40 U	<0.40 U	<0.40 U	<0.50 U	<0.50 U	<0.60 U		<0.50 U		<1.1 U		<1.0
	05/21/03	<0.40 R	<0.50 R	<1.0 R	<0.50 R	<1.0 R	<1.0 R		<5.0 R		<1.0 R		<2.0
11/13/03	<0.40 U	<0.50 U	<1.0 U	<0.50 U	<1.0 U	<1.0 U		<5.0 U		<1.0 U		<2.0	

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Table 1-1. Historic Monitoring Well Groundwater Results Building 550 Former March Air Force Base
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		Volatile Organics											
Well Number	Date	Benzene (µg/L)	Chlorobenzene (µg/L)	1,1-DCA (µg/L)	1,2-DCA (µg/L)	cis-1,2-DCE (µg/L)	Ethylbenzene (µg/L)	Ethylene Dibromide (µg/L)	MTBE (µg/L)	Methylene Chloride (µg/L)	Toluene (µg/L)	1,2,4-TCB (µg/L)	Total Xylenes (µg/L)
MCL ^(a)		1	70	5	0.5	6	300	0.05	13	5	150	5	1,750
	06/24/04	<0.40 U	<0.50 U	<1.0 U	<0.50 U	<1.0 U	<1.0 U		<5.0 U		<1.0 U		<2.0
	08/31/05	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<3.0
	12/01/05	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<3.0
550MW05	06/15/99												
	09/13/99	<0.50	<0.50	<0.50	17	<0.50	<0.50		1.2	<1.0	<0.50		<1.0
	11/11/99												
	03/14/00	<0.054	<0.090	<0.056	17	<0.043	<0.088		0.90	<1.0	<0.034		<0.22
	05/03/00	<0.054	<0.090	<0.056	13	<0.043	<0.088		<0.097	<1.0	0.30		<0.22
	07/31/01	<0.40 U	<0.40 U	<0.40 U	11	<0.50 U	<0.60 U		0.67		<1.1 U		<1.0
	12/12/01	<0.89	<0.40 U	<0.40 U	8.7	<0.50 U	<0.60 J		0.55		<1.2		<1.5
	07/11/02	<0.45	<0.40 U	<0.40 U	7.1	<0.50 U	<0.60 J		0.56		<1.1 J		<1.1
	12/11/02	<0.40 U	<0.40 U	<0.40 U	8.0	<0.50 U	<0.60 U		0.50		<1.1 U		<1.0
	05/22/03	<0.40 U	<0.50 U	<1.0 U	5.2	<1.0 U	<1.0 U		0.19 J		<1.0 U		<2.0
	11/14/03	<0.40 U	<0.50 U	<1.0 U	4.5	<1.0 U	<1.0 U		<5.0 U		<1.0 U		<2.0
	06/25/04	<0.40 U	<0.50 U	<1.0 U	4.3	<1.0 U	<1.0 U		<5.0 U		<1.0 U		<2.0
	08/31/05	<1.0	<1.0	<1.0	3.5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<3.0
	12/01/05	<1.0	<1.0	<1.0	2.6	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<3.0
550MW06	06/15/99												
	09/14/99	130	<0.50	<0.50	7.0	<0.50	3.3		<0.25	<1.0	<0.50		7.6
	11/10/99												
	03/20/00	<0.054	<0.090	<0.056	<0.065	<0.043	<0.088		<0.097	<1.0	<0.034		<0.22
	05/04/00	<0.054	<0.090	<0.056	<0.065	<0.043	<0.088		<0.097	0.30	<0.034		<0.22
	08/01/01	0.31 J	<0.40 U	<0.40 U	0.28 J	<0.50 U	<0.60 U		<0.50 U		<1.1 U		<1.0
	12/13/01	1.2	<0.40 U	<0.40 U	<0.50 U	<0.50 U	0.35 J		<0.50 U		1.2		0.44 J
	07/10/02	<2.2	<0.40 U	<0.40 U	<0.50 U	<0.50 U	<1.6		<0.50 U		<1.7		<4.6
	11/26/02	<0.40 U	<0.40 U	<0.40 U	<0.50 U	<0.50 U	<0.60 U		<0.50 U		<1.1 U		<1.0
	05/21/2003 ^(b)	<0.40 R/<0.40 U	<0.50 R/<0.50 U	<1.0 R/<1.0 U	<0.50 R/<0.50 U	<1.0 R/<1.0 U	<1.0 R/<1.0 U		<5.0 R/<5.0 U		<1.0 R/<1.0 U		<2.0/<2.0
	11/11/03	<0.40 U	<0.50 U	<1.0 U	<0.50 U	<1.0 U	<1.0 U		<5.0 U		<1.0 U		<2.0
	06/24/04	<0.40 U	<0.50 U	<1.0 U	<0.50 U	<1.0 U	<1.0 U		<5.0 U		<1.0 U		<2.0
	08/31/05	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<3.0
	12/01/05	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<3.0
550MW07	06/15/99												
	09/13/99	1.3	<0.50	<0.50	2.2	<0.50	<0.50		<0.25	<1.0	<0.50		<1.0
	12/17/99	0.90	<0.054	<0.035	1.7	<0.15	<0.092		<0.14	1.0	<0.085		<0.15
	03/14/00	0.70	<0.090	<0.056	2.0	<0.043	<0.088		<0.097	0.90	<0.034		<0.22
	05/04/00	0.40	<0.090	<0.056	1.0	<0.043	<0.088		<0.097	<1.0	<0.034		<0.22
	08/01/01	0.53	<0.40 U	<0.40 U	1.7	<0.50 U	<0.60 U		<2.9		<1.1 U		<1.0
	12/13/01	1.2	<0.40 U	<0.40 U	1.1	<0.50 U	0.24 J		34		<1.1 U		0.30 J
	07/10/02	<1.1	<0.40 U	<0.40 U	1.7	<0.50 U	<0.70		3.6		<1.1 J		<2.2
	12/11/02	<0.40 U	<0.40 U	<0.40 U	1.5	<0.50 U	<0.60 U		3.1		<1.1 U		<1.0
	05/22/03	0.12 J	<0.50 U	<1.0 U	1.4	<1.0 U	<1.0 U		2.9 J		<1.0 U		<2.0
	11/13/2003 ^(b)	<0.40 U/<0.40 U	<0.50 U/<0.50 U	<1.0 U/<1.0 U	<0.50 U/0.67	<1.0 U/<1.0 U	<1.0 U/<1.0 U		1.5 J/1.2 J		<1.0 U/<1.0 U		<2.0/<2.0
	06/25/04	<0.40 U	<0.50 U	<1.0 U	1.2	<1.0 U	<1.0 U		7.9		<1.0 U		<2.0
	09/01/05	<1.0	<1.0	<1.0	0.46 J	<1.0	<1.0	<1.0	42	<1.0	<1.0	<1.0	<3.0
	12/01/05	<1.0/<1.0	<1.0/<1.0	<1.0/<1.0	0.91 J/0.85 J	<1.0/<1.0	<1.0/<1.0	<1.0/<1.0	5.9/5.6	<1.0/<1.0	<1.0/<1.0	<1.0/<1.0	<3.0/<3.0
550MW08	06/15/99												
	09/14/99	77	<0.50	<0.50	36	<0.50	33		86	<1.0	2.2		73
	12/17/99	51	<0.054	<0.035	43	<0.15	18		120	2.6	1.0		33
	03/20/00	23	<0.090	<0.056	26	<0.043	6.0		55	<1.0	<0.034		12

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Table 1-1. Historic Monitoring Well Groundwater Results Building 550 Former March Air Force Base
(Page 4 of 5)

		Volatile Organics											
Well Number	Date	Benzene (µg/L)	Chlorobenzene (µg/L)	1,1-DCA (µg/L)	1,2-DCA (µg/L)	cis-1,2-DCE (µg/L)	Ethylbenzene (µg/L)	Ethylene Dibromide (µg/L)	MTBE (µg/L)	Methylene Chloride (µg/L)	Toluene (µg/L)	1,2,4-TCB (µg/L)	Total Xylenes (µg/L)
MCL ^(a)		1	70	5	0.5	6	300	0.05	13	5	150	5	1,750
	05/05/00	150	<0.090	<0.056	45	<0.043	45		130		4.0		122
	08/01/01	190	<0.40 U	<0.40 U	39	<0.50 U	21		110	<1.0	1.0 J		48
	12/13/01	300	<0.40 U	<0.40 U	23	<0.50 U	94		170		4.4		338
	07/12/02	75	<4.0 U	<4.0 U	36	<5.0 U	31		190		5.3 J		88
	12/02/02	4.4	<0.40 U	<0.40 U	26	<0.50 U	2.8		190		<1.1 U		1.07
	06/24/03	0.13 J	0.36 J	<1.0 U	12.72	<1.0 U	<1.0 U	<1.0 U	40.1	<1.0 F	<1.0 U	<1.0 U	<2.0
	12/02/03	0.40	0.35 J	<1.0 U	8.9	0.84 J	<1.0 U		46.8		<1.0 U		<2.0
	06/28/04	<2.0 U	<2.5 U	<5.0 U	17.0	<5.0 U	<5.0 U		183		<5.0 U		<10
	09/01/2005 ^(b)	<2.5/<2.5	<2.5/<2.5	<2.5/<2.5	11/10	<2.5/<2.5	<2.5/<2.5	<2.5/<2.5	130/120	<2.5/<2.5	<2.5/<2.5	<2.5/<2.5	<7.5/<7.5
	12/02/05	<2.5	<2.5	<2.5	12	<2.5	1.8 J	<2.5	180	<2.5	<2.5	<2.5	4.2 J
550MW09	06/15/99												
	09/13/99	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50		<0.25	<1.0	<0.50		<1.0
	11/11/99												
	03/14/00	<0.054	<0.090	<0.056	<0.065	<0.043	<0.088		<0.097	0.70	<0.034		<0.22
	05/03/00	<0.054	<0.090	<0.056	<0.065	<0.043	<0.088		<0.097	<1.0	0.50		<0.22
	08/01/01	0.23 J	<0.40 U	<0.40 U	<0.50 U	<0.50 U	<0.60 U		<0.50 U		<1.1 U		<1.0
	12/13/01	0.46	<0.40 U	<0.40 U	<0.50 U	<0.50 U	0.21 J		<0.50 U		0.50 J		0.21 J
	07/10/2002 ^(b)	<2.6/<2.4	<0.40 U/<0.40 U	<0.40 U/<0.40 U	<0.50 U/<0.50 U	<0.50 U/<0.50 U	<2.2/<2.1		<0.50 U/<0.50 U		<2.7/<2.5		<6.9/<6.6
	11/26/2002 ^(b)	0.58/0.71	<0.40 U/<0.40 U	<0.40 U/<0.40 U	<0.50 U/<0.50 U	<0.50 U/<0.50 U	<0.60 U/<0.60 U		<0.50 U/<0.50 U		<1.1 U/<1.1 U		<1.0/<1.0
	05/21/03	<0.40 U	<0.50 U	<1.0 U	<0.50 U	<1.0 U	<1.0 U		<5.0 U		<1.0 U		<2.0
	11/13/03	<0.40 U	<0.50 U	<1.0 U	<0.50 U	<1.0 U	<1.0 U		<5.0 U		<1.0 U		<2.0
	06/24/04	<0.40 U	<0.50 U	<1.0 U	<0.50 U	<1.0 U	<1.0 U		<5.0 U		<1.0 U		<2.0
	08/31/05	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<3.0
	12/01/05	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<3.0
550MW10	01/31/02	1,860	<1.0	<1.0	80	2.1	481		554	<1.0	2,960		4,530
	07/11/02	590	<10 U	<10 U	25	<12 U	190		22		400		430
	09/09/02	630	<10 U	<10 U	<12 U	<12 U	150		30		280		300
	12/11/02	640	<0.40 U	<0.40 U	<0.50 U	<0.50 U	220		<0.50 U		330		520
	04/09/03	418 M	<0.50 U	<1.0 U	<0.50 M	<1.0 U	92.04 M		67.46 J		56.58		154.53
	05/27/03	5,500	<100	<100	<100	<100	1,200	<100	770	<100	4,800	<100	6,900
	06/23/2003 ^(b)	2,400/2,500	<50/<50	<50/<50	<50/<50	<50/<50	520/530	<50/15 J	500/510	<50/<50	2,900/2,900	<50/<50	4,700/4,700
	07/28/03	2,400	<100	<100	<100	<100	470	<100	550	<100	2,700	<100	4,500
	08/26/03	3,200	<120	<120	<120	<120	550	<120	610	<120	7,400	<120	9,500
	09/26/03	2,400	<50	<50	<50	<50	380	<50	480	<50	2,200	<50	4,200
	10/21/03	2,800	<50	<50	<50	<50	500	<50	570	<50	2,900	<50	4,600
	11/25/2003 ^(b)	2,500/2,400	<50/<50	<50/<50	<50/<50	<50/<50	380/370	<50/<50	590/580	<50/<50	2,400/2,300	<50/<50	4,100/3,900
	12/22/03	2,900	<50	<50	<50	<50	340	<50	710	21 J (B)	2,400	<50	4,100
	01/22/04	1,900	<50	<50	<50	<50	390	<50	400	<50	1,300	<50	4,000
	02/27/04	1,900	<50	<50	43 J	<50	270	<50	550	<50	2,500	<50	7,400
	04/13/2004 ^(b)	1,600/1,500	<50/<25	<50/<25	<50/<25	<50/<25	370/380	<50/<25	330/380	<50/<25	1,500/1,500	<50/<25	3,100/2,870
	07/27/04	1,900	<50	<50	<50	<50	360	<50	460	<50	2,200	<50	2,900
	10/26/04	2,300	<33	<33	<33	<33	420	<33	620	<33	2,200	<33	3,300
	01/26/05	1,800	<33	<33	<33	<33	300	<33	570	<33	1,300	<33	3,100
	04/27/05	780	<25	<25	14 J	<25	100	<25	230	<25	830	<25	1,700
	08/08/2005 ^(b)	1,600/1,700	<25/<25	<25/<25	<25/<25	<25/<25	310/330	<25/<25	470/510	<25/<25	1,200/1,500	<25/<25	3,000/3,300
	11/02/05	1,900	<33	<33	<33	<33	360	<33	530	<33	1,200	<33	3,600
	02/01/06	1,700	<33	<33	<33	<33	310	<33	460	<33	1,200	<33	3,000
550MW11	01/30/02	9.1	<1.0	<1.0	6.6	<1.0	2.3		52	<1.0	16		14.6
	07/11/02	<0.66	<0.40 U	<0.40 U	5.7	<0.50 U	<0.60 J		44		<1.1 J		<1.3

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Table 1-1. Historic Monitoring Well Groundwater Results Building 550 Former March Air Force Base
(Page 5 of 5)

Well Number	Date	Volatile Organics											
		Benzene	Chlorobenzene	1,1-DCA	1,2-DCA	cis-1,2-DCE	Ethylbenzene	Ethylene Dibromide	MTBE	Methylene Chloride	Toluene	1,2,4-TCB	Total Xylenes
		(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
MCL ^(a)		1	70	5	0.5	6	300	0.05	13	5	150	5	1,750
	09/09/2002 ^(b)	<0.40 U/<0.40 U	<0.40 U/<0.40 U	<0.40 U/<0.40 U	3.5/3.2	<0.50 U/<0.50 U	<0.60 U/<0.60 U		26/21		<1.1 U/<1.1 U		<1.0/<1.0
	12/02/02	<0.40 U	<0.40 U	<0.40 U	6.1	<0.50 U	<0.60 U		110		<1.1 U		<1.0
	04/09/03	0.30 J	<0.50 U	<1.0 U	6.59	<1.0 U	0.30 J		187		<1.0 U		0.18 J
	05/22/03	<0.40 U	<0.50 U	<1.0 U	7.8	<1.0 U	<1.0 U		190		<1.0 U		<2.0
	11/14/03	<0.40 U	<0.50 U	<1.0 U	9.1	<1.0 U	<1.0 U		196		<1.0 U		<2.0
	06/25/04	<0.40 U	<0.50 U	<1.0 U	9.8	<1.0 U	<1.0 U		156		<1.0 U		<2.0
	09/01/05	<2.5	<2.5	<2.5	5.2	<2.5	<2.5	<2.5	140	<2.5	<2.5	<2.5	<7.5
	12/02/05	<1.6	<1.6	<1.6	4.4	<1.6	<1.6	<1.6	120	<1.6	<1.6	<1.6	<4.7
550MW12	04/09/2003 ^(b)	<0.40 U/<0.40 U	<0.50 U/<0.50 U	<1.0 U/<1.0 U	<0.50 U/<0.50 U	<1.0 U/<1.0 U	<1.0 U/<1.0 U		<5.0 U/<5.0 U		<1.0 U/<1.0 U		<2.0/<2.0
	05/22/03	<0.40 U	<0.50 U	<1.0 U	<0.50 U	<1.0 U	<1.0 U		<5.0 U		<1.0 U		<2.0
	08/22/03	<0.40 U	<0.50 U	<1.0 U	<0.50 U	<1.0 U	<1.0 U		<5.0 U		<1.0 U		<2.0
	11/13/03	<0.40 U	<0.50 U	<1.0 U	<0.50 U	<1.0 U	<1.0 U		<5.0 U		<1.0 U		<2.0
	06/24/04	<0.40 U	<0.50 U	<1.0 U	<0.50 U	0.61 J	<1.0 U		<5.0 U		<1.0 U		<2.0
	09/01/05	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<3.0
	12/01/05	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<3.0
550MW13	04/09/03	<0.40 U	<0.50 U	<1.0 U	<0.50 U	<1.0 U	<1.0 U		0.34 J		<1.0 U		<2.0
	05/21/03	<0.40 U	<0.50 U	<1.0 U	<0.50 U	<1.0 U	<1.0 U		0.81 J		<1.0 U		<2.0
	08/25/03	<0.40 U	<0.50 U	<1.0 U	<0.50 U	<1.0 U	<1.0 U		0.40 J		<1.0 U		<2.0
	11/13/03	<0.40 U	<0.50 U	<1.0 U	<0.50 U	<1.0 U	<1.0 U		0.65 J		<1.0 U		<2.0
	06/24/04	<0.40 U	<0.50 U	<1.0 U	<0.50 U	<1.0 U	<1.0 U		0.73 J		<1.0 U		<2.0
	12/08/04	<0.40 U	<0.50 U	<1.0 U	<0.50 U	<1.0 U	<1.0 U		1.3 J		<1.0 U		<2.0
	08/31/05	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.5	<1.0	<1.0	<1.0	<3.0
	12/01/05	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.3	<1.0	<1.0	<1.0	<3.0
550MW14	06/09/03	0.12 J	<0.50 U	<1.0 U	1.0	<1.0 U	<1.0 U		25.28		0.14 J		<2.0
	08/25/03	<0.40 U	<0.50 U	<1.0 U	0.74	<1.0 U	<1.0 U		23.4		<1.0 U		<2.0
	11/11/03	<0.40 U	<0.50 U	<1.0 U	0.40 J	<1.0 U	<1.0 U		34.1		<1.0 U		<2.0
	06/23/04	<0.40 U	0.86	<1.0 U	<0.50 U	1.2	<1.0 U		41.8		<1.0 U		<2.0
	12/08/04	<0.40 U	<0.50 U	<1.0 U	<0.50 U	<1.0 U	<1.0 U		3.3 J		<1.0 U		<2.0

Notes

Results greater than regulatory maximum contaminant levels have been bolded.

^(a) Federal (U.S. EPA) and Title 22 California Code of Regulations (CDHS) - MCLs (09/12/2003)

^(b) Duplicate samples were collected

1,1-DCA 1,1-dichloroethane

1,2-DCA 1,2-dichloroethane

cis-1,2-DCE cis-1,2-dichloroethene

MTBE methyl tert-butyl ether

1,2,4-TCB 1,2,4-trichlorobenzene

Laboratory Data Qualifiers

D

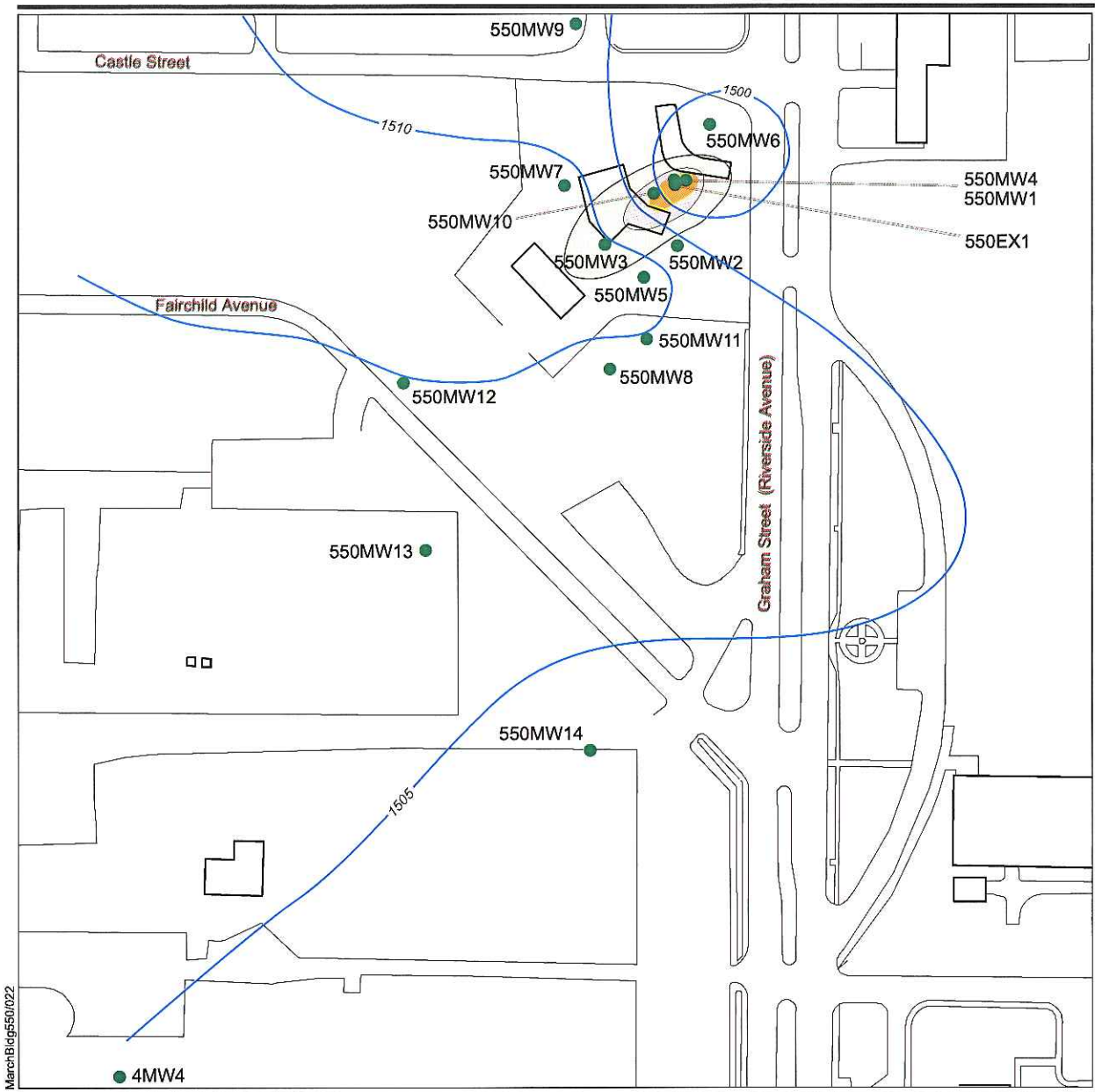
F The analyte was positively identified but the associated numerical value is below the RL

J The analyte was positively identified, the quantitation is an estimation

M A Matrix effect was present

U The analyte was analyzed for, but not detected. The associated numerical value is at or below the MDL

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EXPLANATION

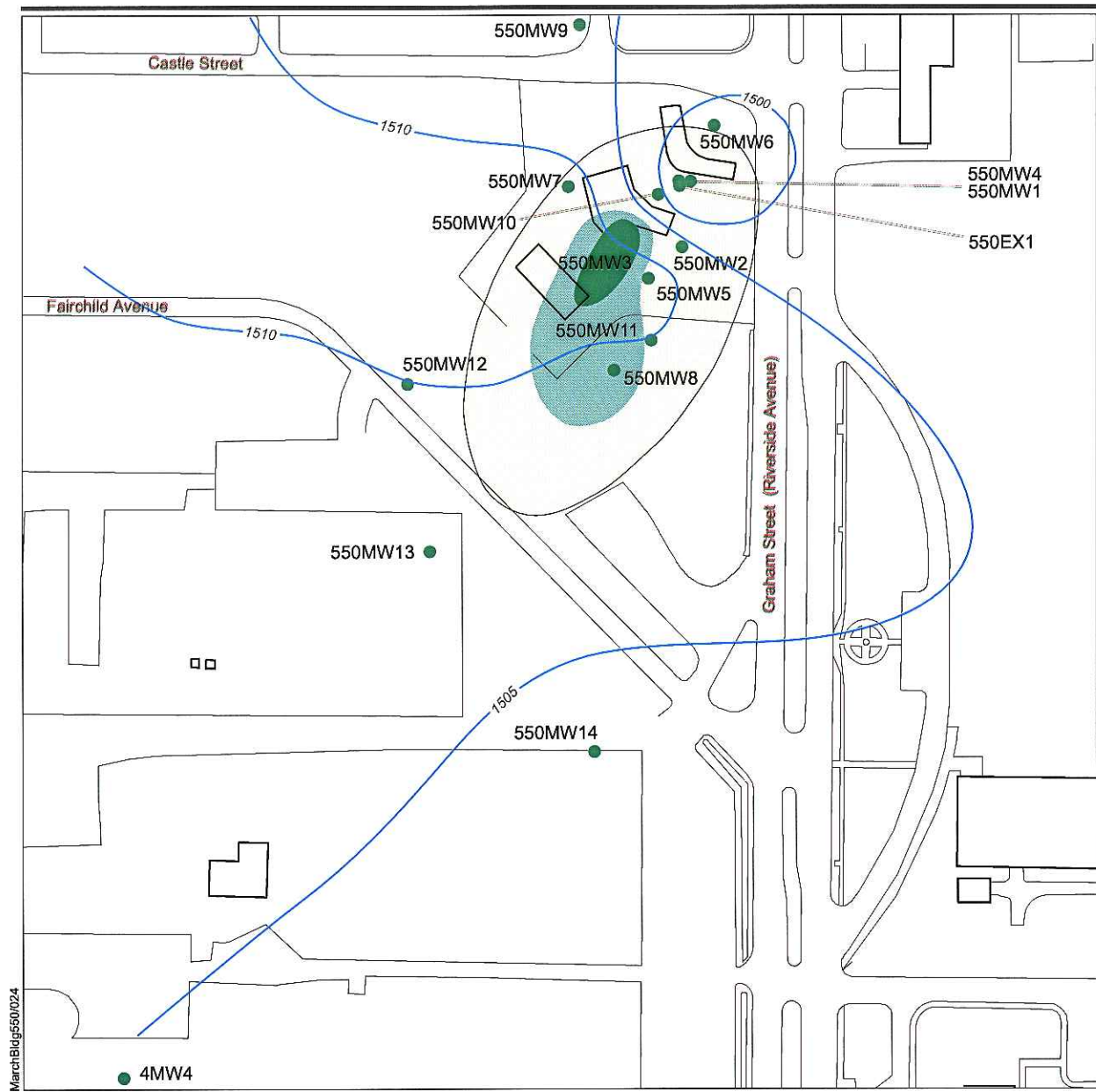
- Monitoring Wells
- Roads
- Buildings
- Groundwater Contours
- Benzene Plume Outline > 1 µg/L
- Benzene Plume Outline > 100 µg/L
- Benzene Plume Outline > 1000 µg/L

Building 550 Benzene Plume Former March Air Force Base, California



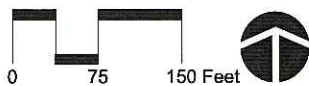
Source: (MWH 2004)

Figure 1-6



EXPLANATION

- Monitoring Wells
- Roads
- Buildings
- 1505 Groundwater Contours
- 1, 2 - DCA Plume Outline > 0.5 µg/L
- 1, 2 - DCA Plume Outline > 10 µg/L
- 1, 2 - DCA Plume Outline > 20 µg/L



Source: (MWH 2004)

**Building 550
1, 2 - DCA Plume
Former March Air
Force Base, California**

Figure 1-7

Building 549 (service center). The plume has begun to migrate downgradient and concentrations greater than 10 µg/L are now reported in MW 550MW08. MTBE was detected in seven MWs above the Maximum Contaminant Level (MCL) (13 µg/l) at a maximum concentration of 2,300 µg/l in MW 550MW03. As shown on Figure 1-8, the MTBE plume begins near the fueling stations tank farm and extends beyond the most downgradient well (550MW14). MTBE concentrations of 41.8 µg/l were reported in MW 550MW14 in June 2004 (MWH, 2005). The extent of MTBE in groundwater to the west is confined by MWs 550MW12 and 550MW13. The extent to the east is un-defined. The highest reported concentration of MTBE was collected in MW 550MW03; however, there is no reported source of MTBE in soil from the borehole above this point.

1.4 PROJECT MANAGEMENT

The project management team for the Building 550 investigation and remedial work under this RCAWP along with their responsibilities are summarized below.

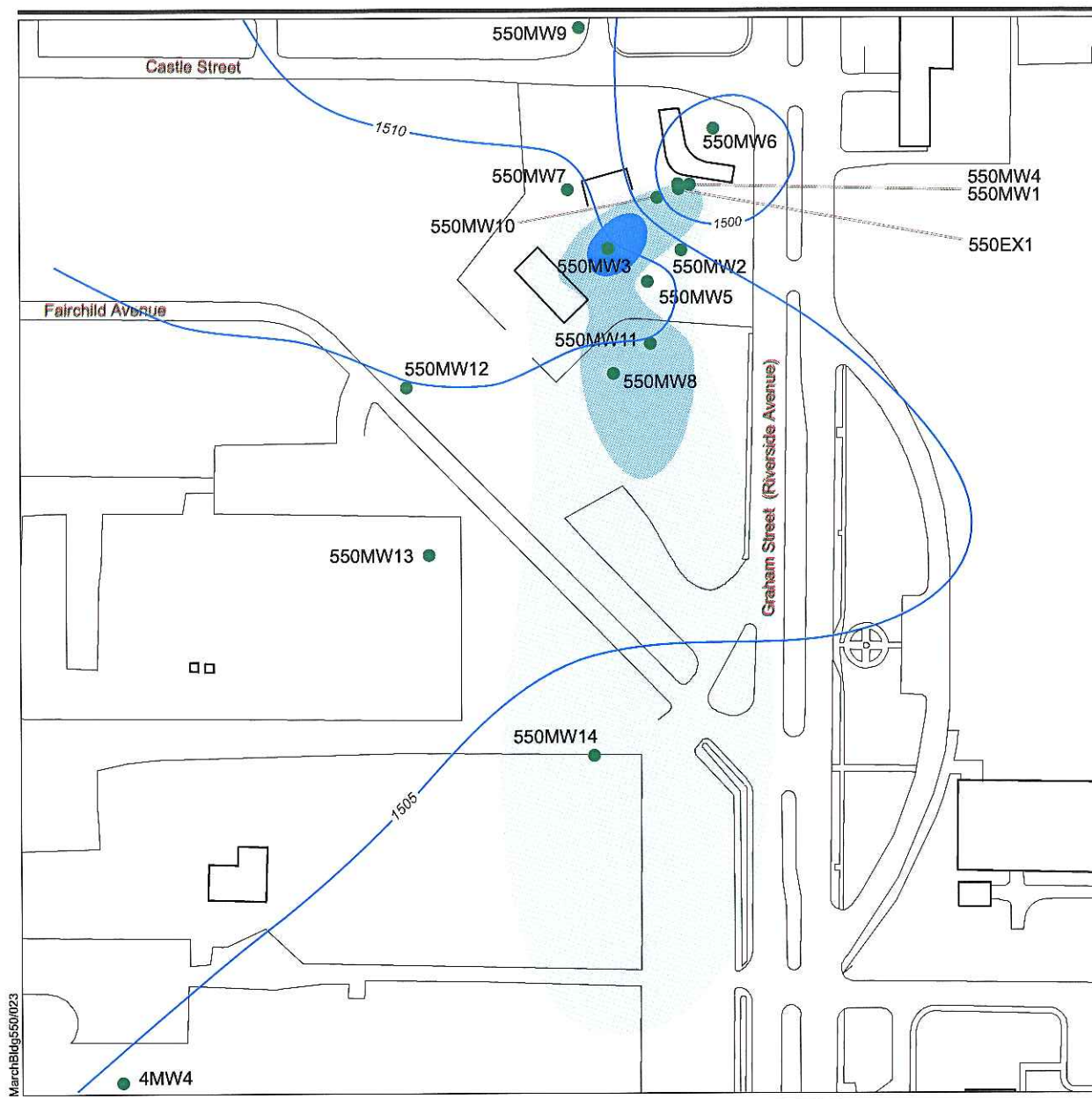
Mr. Jerry Bingham, PE, Team Chief from AFCEE. Mr. Bingham is responsible for all contract management and procurement issues and is key to allowing flexibility in conducting the field work and providing contractual guidance for this project.

Mr. Rick Solander, AFRPA, McClellan, AFB, CA. Mr. Solander is the AFRPA Program Manager and Base Environmental Coordinator for the BRAC sites at the former March AFB. Mr. Solander is responsible for the review of documents and the site manager for this site.

Mr. John Broderick, California RWQCB, Santa Ana Region. Mr. Broderick is the RPM for the RWQCB, Santa Ana Region at March. The RWQCB is the lead agency for this site because it is a fuels-only release. Mr. Broderick is responsible for the technical review of the planning document, approving the RCAWP, reviewing and approving the field data, and for reviewing and approving decisions on sampling, analytical results, and proposed remedial actions.

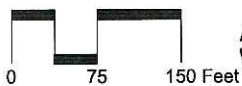
Earth Tech, Inc. Earth Tech is responsible for the Building 550 Investigation and Remedial Actions, and as such is responsible for the preparation of the planning documents, implementing the field work described in this document and collecting sufficient data to fill the remaining data gaps at the Building 550 source and downgradient area. The Earth Tech Project Team includes the following individuals:

- Project Manager - Bill Muir, PG
- Hydrogeologist - Paul Peterson, PG, CEG
- Quality Assurance/Quality Control Manager - Elisabeth Fruth
- Project Chemist - Janet Tsukamoto
- Remediation Engineer - Matthew Hansen, Sr.
- Data Manager - Bret Glidden
- Direct Push/CPT Subcontractor - Gregg In-Situ
- On-Site Field Laboratory - H & P Mobile Geochemistry
- Drilling Subcontractor - Gregg Drilling
- Project Laboratory - STL Los Angeles



EXPLANATION

- Monitoring Wells
- Roads
- ▭ Buildings
- 1505 — Groundwater Contours
- MTBE Plume Outline > 13 µg/L
- MTBE Plume Outline > 130 µg/L
- MTBE Plume Outline > 1300 µg/L



Source: (MWH 2004)

Building 550 MTBE Plume Former March Air Force Base, California

Figure 1-8

2.0 PROJECT OBJECTIVES, SCHEDULE, AND CLEANUP GOALS

2.1 PROJECT OBJECTIVES

The objectives of this RCAWP is to establish ultimate cleanup goals that can be easily obtained and are economical. This work plan presents the activities necessary to further characterize the soil and groundwater contamination at Building 550, defines the potential movement or reduction in fuel contamination in the soil and groundwater at Building 550, describes a secondary point source of contamination (MTBE) impacting the groundwater beneath the site, fill existing data gaps, and delineate the vertical and horizontal extent of the growing MTBE plume.

The RCAWP also presents additional remedial activities to enhance the mitigation of the contaminants in soil and groundwater associated with the site and expedite the remedial process. These activities will include installation of groundwater monitoring and extraction wells based on the findings of the investigation. The characterization activities will assist in decisions for the optimal placement of wells and well screens and options for future remedial processes.

In support of this objective, Earth Tech will:

- Conduct a point source investigation around Building 549, Building 550, and the removed USTs utilizing Direct Push Technology with Ultra Violet Induced Fluorescence (UVIF) for soil characterization and Hydropunch™ sampling for groundwater sample collection
- Perform downgradient/cross-gradient characterization of the MTBE contaminant plume utilizing Direct Push Technology with groundwater sample collection
- Collect water level measurements from all area wells to more accurately define groundwater flow gradients
- Analyze groundwater samples using both on-site mobile laboratory and fixed off-site laboratory
- Collect soil samples for analysis using fixed laboratory
- Document all field operations, quantify the contaminant concentrations, report data, and recommend remedial action modifications.

After the remedial investigation and further site characterization, Earth Tech will implement some or all of the following remedial treatment changes based on the results:

- Install additional monitoring well(s) to monitor the leading edge of the MTBE plume

- Install additional extraction well(s) with extraction pumps to remove contaminant-laden vapor/groundwater from the source area
- Connect new wells to existing SVE and groundwater treatment systems, modify existing PAT system capability with supplemental treatment if required (carbon polish) in the process stream before sewer discharge to continue operation in accordance with existing discharge requirements
- Apply for water treatment discharge permit (if required)
- Install groundwater extraction pump(s) into new and existing monitoring well(s) for immediate remedial action
- Install air sparge, oxygen sparge, or ozone injection system utilizing new or existing wells to accelerate remedial actions, if appropriate.

2.2 PROJECT SCHEDULE

The proposed schedule for the work is presented in Figure 2-1. The tasks identified in the schedule may change as necessary. Currently, the anticipated tasks include:

- Preparation of planning documents, including this addendum to the existing work plans for the site, an updated health and safety plan (HASP), and a sampling and analysis plan (SAP)
- Field work, including direct push techniques, and soil and groundwater sampling
- Data interpretation and evaluation
- Installation of additional monitoring and extraction wells
- Modification of existing PAT and SVE systems, piping, and ancillary equipment for expanded extraction capabilities
- Specify, purchase, and install alternative remedial technology equipment (oxygen or ozone generator, oxygen sparge equipment) if required
- Evaluation of soil data and groundwater sampling data, and groundwater level measurements
- Prepare draft and final work plan field implementation reports
- Continue operation and maintenance at the site until remediation is complete.

2.3 CLEANUP GOALS

The cleanup goals for this site are to restore the groundwater to accepted water quality limits and to abate any contaminant source from soil to prevent continued leaching from the affected soils at levels that may cause the underlying groundwater to exceed applicable water quality objectives. Table 2-1 presents the proposed cleanup goals. Where noted site specific cleanup goals have been used. In groundwater a site-specific goal for benzene of 10 µg/l has been used; for all other analytes, the more stringent State of California and federal MCLs have been identified.

In soil, the risk-based U.S EPA residential soil PRGs for direct contact exposure pathways have been utilized. For fuel compounds that have no MCL or PRG, site-specific cleanup goals are presented.

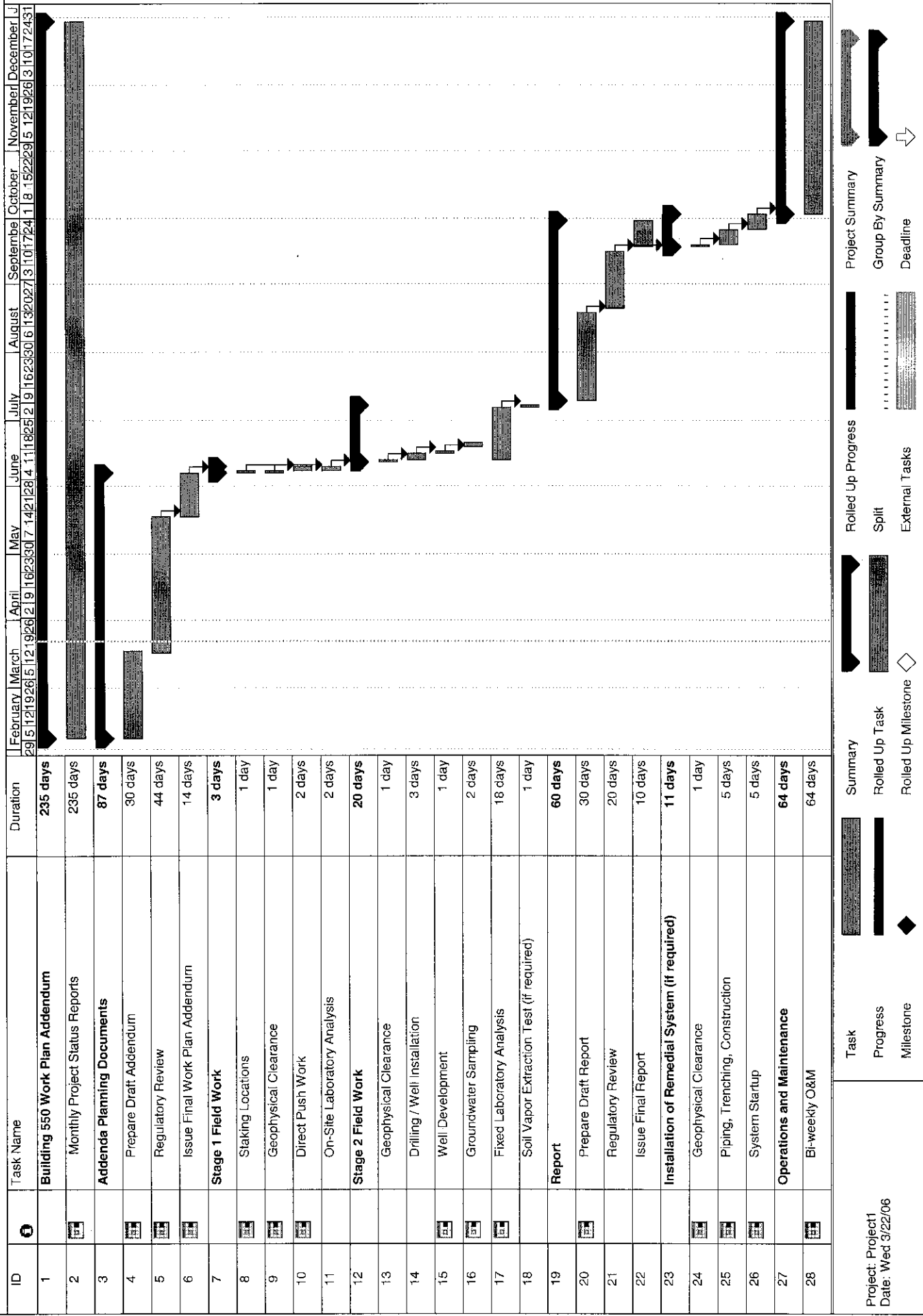
Table 2-1. Soil and Groundwater Cleanup Goals

Contaminant	State or Federal Drinking Water Standard	USEPA PRGs for Residential Soil
Benzene	10 µg/L ^(a)	0.64 mg/kg
Ethylbenzene	700 µg/L (state and federal)	400 mg/kg
Toluene	150 µg/L (state)	520 mg/kg
Xylenes (total)	1,750 µg/L (state)	270 mg/kg
MTBE	13 µg/L (federal)	32 mg/kg
1,2-Dichloroethane (1,2-DCA)	0.5 µg/L	0.28 mg/kg
TPH gas	NA	100 mg/kg ^(b)
TPH diesel	NA	1,000 mg/kg ^(b)

Notes: ^(a) Proposed site-specific clean-up goal.

^(b) The Site 43 March ARB Work Plan mitigation goals.

Figure 2-1. Proposed Building 550 RAWPA Project Schedule -2006



3.0 DIRECT PUSH TECHNOLOGIES

Direct Push (DP) technologies use hydraulic pressure to push various measurement and sample collection equipment attached to the end of a steel penetration rod into the subsurface. The penetration rods are sectional solid steel or hollow tubes (approximately 3 feet long) that screw together to form a single continuous rod. DP devices generate no cuttings, produce little disturbance, and reduce contact between field personnel and contaminants, since the penetration push rods are decontaminated during retrieval. A variety of penetration tests exist for environmental investigations. DP technologies to be used during Stage I characterization include Cone Penetrometer Test (CPT) for lithology and Pore Pressure, UVIF for hydrocarbon screening of soil and groundwater, and Hydropunch™ for collection of groundwater samples.

3.1 CONE PENETROMETER TEST

The CPT provides a continuous profile of measurements, and it is rapid, repeatable, reliable, and cost effective. The CPT uses an integrated electronic cone system. The soundings are conducted using a 30-ton rig pushing a 20-ton capacity cone with a tip area of 15 square centimeters (cm²) and a friction sleeve area of 225 cm². The cone is designed with an equal end area friction sleeve and a tip end area ratio of 0.85. A standard operating procedure (SOP) for CPT is provided in Appendix B.

3.2 PORE PRESSURE DISSIPATION TEST

Pore Pressure Dissipation Tests conducted at various intervals measure hydrostatic water pressures and determine the approximate depth of the groundwater table. A Pore Pressure Dissipation Test is conducted when the cone is halted at specific intervals determined by the field representative. The variation of penetration pore pressure with time is measured behind the tip of the cone and recorded by the computer system. Pore Pressure Dissipation data can be interpreted to provide estimates of (a) equilibrium piezometric pressure, (b) phreatic surface, (c) in-situ horizontal coefficient of consolidation, and (d) in-situ horizontal coefficient of permeability.

3.3 ULTRA VIOLET INDUCED FLUORESCENCE

UVIF or equivalent used in conjunction with the standard CPT piezocone tip can identify areas of high hydrocarbon concentrations based on the premise that fuel mixed in soil and groundwater fluoresce when irradiated by ultra violet light. Gasoline fuel is the source of the BTEX, 1,2-DCA, and MTBE. The UVIF can be used as a field screening tool to indicate the presence of gasoline in soil and groundwater. By measuring the UVIF intensity of the soil and groundwater in different locations and depths, the lateral and vertical extent of fuel contamination in the ground can be determined. After identifying areas of higher concentrations of hydrocarbons by UVIF methods, samples can be collected for laboratory analysis to better quantify the extent of contamination (see the following sections

on DP soil and groundwater sample collection). The SOP for UVIF is provided in Appendix B.

3.4 DIRECT PUSH SOIL SAMPLING

Soil samples may be collected for lithology and or laboratory analysis. At select locations, a sample will be collected from specific depths. This will be accomplished using a small truck-mounted hydraulic ram and hammer or on a similar type DP rig. The drive point rig will hydraulically push a 2-inch-diameter hollow steel rod into the ground.

The core will be collected in either 3-foot-long coring sleeves or in 12-inch-long coring sleeves. The core will be visually inspected and compared to the CPT push point data to correlate soil lithology to the geologist's interpretation of Unified Soil Classification System designation. While the on-site geologist is logging the lithology, he/she will also be noting the presence or absence of contamination (soil staining, odor, flame ionization detector [FID] readings, etc). Where visual evidence of contamination is present, a soil sample may be collected in stainless steel sleeves for analysis in the off-site laboratory using U.S. EPA Method 8260.

The sample labels will be filled out with the assigned sample ID and the date and time of collection. After soil samples are recovered, the hole will be backfilled with clean material and bentonite chips. If sampling points are installed through concrete or asphalt, like material will be used to repair the sampling location to its original condition. After each push, all equipment in contact with contaminated soil or groundwater will be decontaminated using high-pressure steam prior to reuse. The decontamination water will be contained on site until the holding tank is filled at which time the decontamination fluids will be sent to the treatment compound at Building 550 or containerized into 55-gallon drums for later disposal. Each sampling point will be marked on the surface and surveyed using Global Positioning System (GPS) equipment.

3.5 DIRECT PUSH GROUNDWATER SAMPLING

Groundwater samples may be collected with a drive point sampling device on a small truck-mounted hydraulic ram and hammer or on a similar type CPT rig. The drive point rig will hydraulically push a 2-inch-diameter hollow steel rod into the ground. This rod will be equipped with a polyvinyl chloride (PVC) screen and sacrificial detachable drive point or with a retractable drive point and stainless steel screen. Once the drive rods have been advanced to the selected depths, the drive rod is retracted approximately 2 to 3 feet from the detachable drive point to expose a groundwater sampling screen. Once sufficient water has entered the temporary well, a small diameter stainless steel or disposable bailer will be lowered into the drive rods to collect the groundwater sample.

After groundwater sample collection is complete, the drive casing will be removed from the hole, leaving the tip of the drive point and PVC screen in the hole. Additional groundwater samples may be collected from the same push location at greater depths by retracting the drive rod, installing a new drive tip with well screen, and pushing to a greater depth. Push rod sections that contact water

during any push will be replaced during subsequent pushes to eliminate cross contaminating the groundwater samples.

After each push, all equipment in contact with contaminated soil or groundwater will be decontaminated using high-pressure steam. The decontamination water will be contained on site until the holding tank is filled at which time the decontamination fluids will be sent to an on-base treatment facility or containerized into 55-gallon drums for off-site disposal.

Each hole will be backfilled using a cement-bentonite slurry as the drive rods are retrieved. All drive point locations will be labeled with specific drive point identification number, and each point will be surveyed using GPS equipment.

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4.0 FIELD ACTIVITIES

All field work performed as part of this RCAWP shall be performed in accordance with Installation Restoration Program (IRP) Final Work Plan and Quality Project Plan for the Basewide Remedial Investigation/Feasibility Study (RI/FS) (Earth Tech, 1999), and the Health and Safety Plan for Operation and Maintenance of Soil Vapor and Groundwater Extraction Systems at Building 550, March Air Reserve Base, CA (Earth Tech, 2003b). Changes in practices and procedures from the original RI/FS plan specific to the proposed work contained in this RCAWP shall be noted and called out.

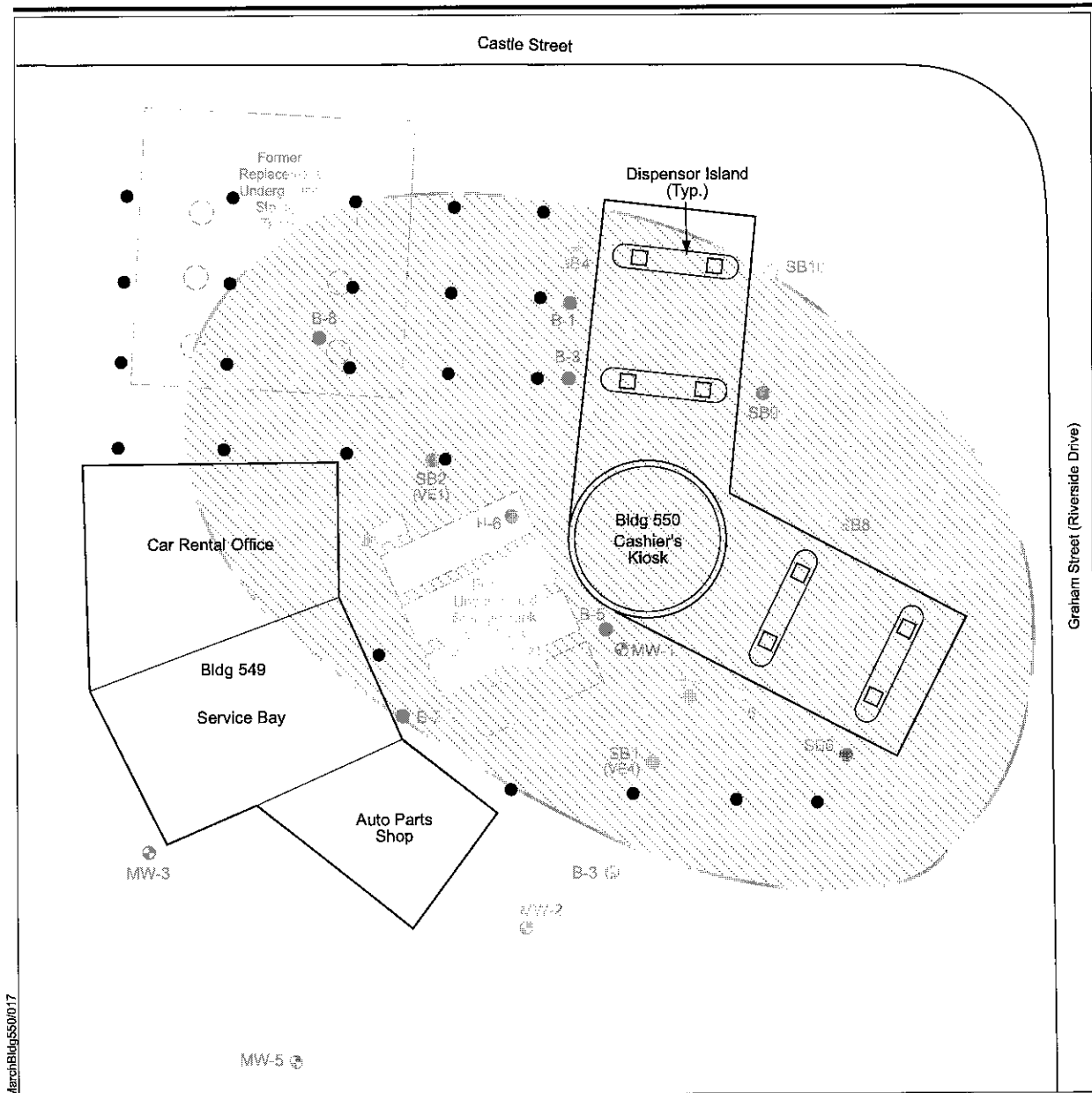
A two-stage approach has been developed for the Building 550 RCAWP. Stage I characterization will include collection of in-situ lithology, soil and groundwater sampling using DP technology, an on-site laboratory for rapid screening level data, and a fixed off-site laboratory for definitive level qualified reporting data. Stage II will utilize hollow stem auger drilling techniques to install extraction and monitoring wells in locations identified during the Stage I characterization. Throughout Stage II, soil samples will be collected with a California Split-Spoon sampler during installation of the extraction well in the source area and groundwater samples collected with a disposable bailer from the monitoring wells in the downgradient region. A backhoe and other trenching equipment may be used to install piping to connect any new extraction wells to the existing treatment systems.

4.1 STAGE I INVESTIGATION

Historic data collected at the site during previous remedial investigations, including tank pull records, guided the installation of the present SVE and groundwater PAT systems. The area of treatment was located around the gas stations initial USTs, transfer piping, and fuel distribution islands. Subsequent groundwater data indicate another potential source of MTBE contamination not realized during past investigations. Based on the groundwater data and the direction of regional groundwater flow, the suspected source area of MTBE is believed to be from the UST and/or piping installed in 1994 approximately 50 feet north of the original UST pit (see Figure 1-5).

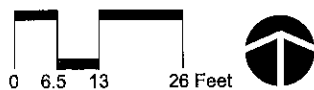
4.1.1 Source Investigation

DP borings with associated testing (CPT and UVIF) and sampling will be conducted north of Building 549 and extending east toward the station fueling islands as shown on Figure 4-1 to locate the source of MTBE in soils affecting the groundwater. The proposed push locations (CPT and UVIF) are northeast (upgradient) of MW 550MW03, which has the greatest MTBE concentration in groundwater. The pushes will be installed at spacing intervals approximately 15 feet apart (subject to change based upon field observations) and extend north toward the latter replacement UST area. The number and location (direction) of CPT/UVIF pushes will be determined by the field engineer/geologist based on data, hand-held instrument readings, and professional judgment. An FID



EXPLANATION

- Soil Boring Location
- Groundwater Monitoring Well
- Proposed Direct Push Sampling Points



**Proposed Direct Push
Locations Source Area
Soil Contamination
Building 550
Former March Air
Force Base, California**

Figure 4-1

judgment. An FID or a photoionizing detector (PID) will be used for localized field screening. The direction of subsequent pushes will be toward the areas of higher concentration (source area) and away from areas of lesser concentration. This will enable the field personnel to define the area of highest concentration of contaminant within the vadose zone (source area). In addition, several direct pushes will be performed near previous installed boreholes B2, B5, and B6 (south of the station fuel dispenser islands) to collect soil and groundwater data to fill the data gaps in contaminant distributions (hot spots) from 30 feet down to 60 feet bgs (see Figure 1-5).

During the source characterization, groundwater samples will be collected at multiple depths to define the vertical extent of contamination. This sample collection will be based upon the screening data provided by the CPT and UVIF data. These samples will be collected using DP technology in sequential order. Samples will be collected starting with the shallowest samples first. As each sample is collected the push rods will be retrieved, decontaminated, and reinstalled in the same hole to be advanced to the next sample depth. This process will continue until the vertical extent of groundwater contamination is defined at each push location.

Once sufficient water has entered the temporary well within the DP rods, a groundwater sample will be collected using a small diameter disposable bailer or decontaminated stainless steel bailer. Sufficient water will be brought to the surface to fill three 40 milliliter (ml) vials for VOCs, taking care not to generate any head space. These water samples will be analyzed by the on-site laboratory for rapid analysis. All groundwater samples will be analyzed using method U.S. EPA Method 8260B. The results will be tabulated and the data plotted on maps and contoured.

The rapid turn-around of analytical results will help to narrow the focus of the investigation on the areas that are likely source(s) of the MTBE/BTEX contamination found in the groundwater near Building 549 and Building 550. The on-site laboratory will also assist in rapidly defining the extent of the downgradient MTBE plume. By collecting in-situ groundwater samples using DP technology, the concentration of these contaminants can be plotted and the results will define the potential release locations as well as provide characterization of the downgradient MTBE plume. These data will be used in determining the placement of additional extraction wells within the source area and monitoring wells in the downgradient region.

In the event that the DP technology reaches refusal or can not reach the depth required, the borings will be installed using hollow stem auger technology. In this scenario, soil and groundwater samples will be collected and processed as defined by the Final Basewide RI/FS (Earth Tech 1999) and traditional associated samples will be collected.

4.1.2 Groundwater Plume Characterization

Contaminant concentrations of MTBE and 1,2-DCA in groundwater have moved downgradient from the UST site. To identify the extent of the contaminant plume,

groundwater samples will be collected from temporary monitoring points using DP technology. Groundwater samples will be collected from the array of direct push boreholes starting at the southern edge of Building 550 and continuing off-site to the south distally along the suspected axis of the plume (MWH 2004) as shown on Figure 4-2. The boreholes will be spaced approximately 100 feet apart and installed until the leading edge of the contaminant plume has been surpassed. Two rows of step-out boreholes will be installed east and west of the plume axis as shown on Figure 4-2. The step-out boreholes will be spaced approximately 100 feet apart and will be sequentially installed until the lateral extents of the groundwater plumes have been identified.

Groundwater samples will be collected with a drive point sampling device near the top of the groundwater table and at additional vertical increments. Up to three groundwater samples will be collected and analyzed from each DP location. The data will indicate localized concentrations in the groundwater. The sample collection depths will be based on lithology and collected in permeable areas of sandy (porous) soils. Additionally, geologic sand stringers and local groundwater flow may not occur in the direction as presented and the transect pushes will identify any variations in the localized concentration shifts in groundwater. These pushes will determine the areal and vertical extents of contaminant impacted groundwater as well as the area of greatest contaminant concentrations.

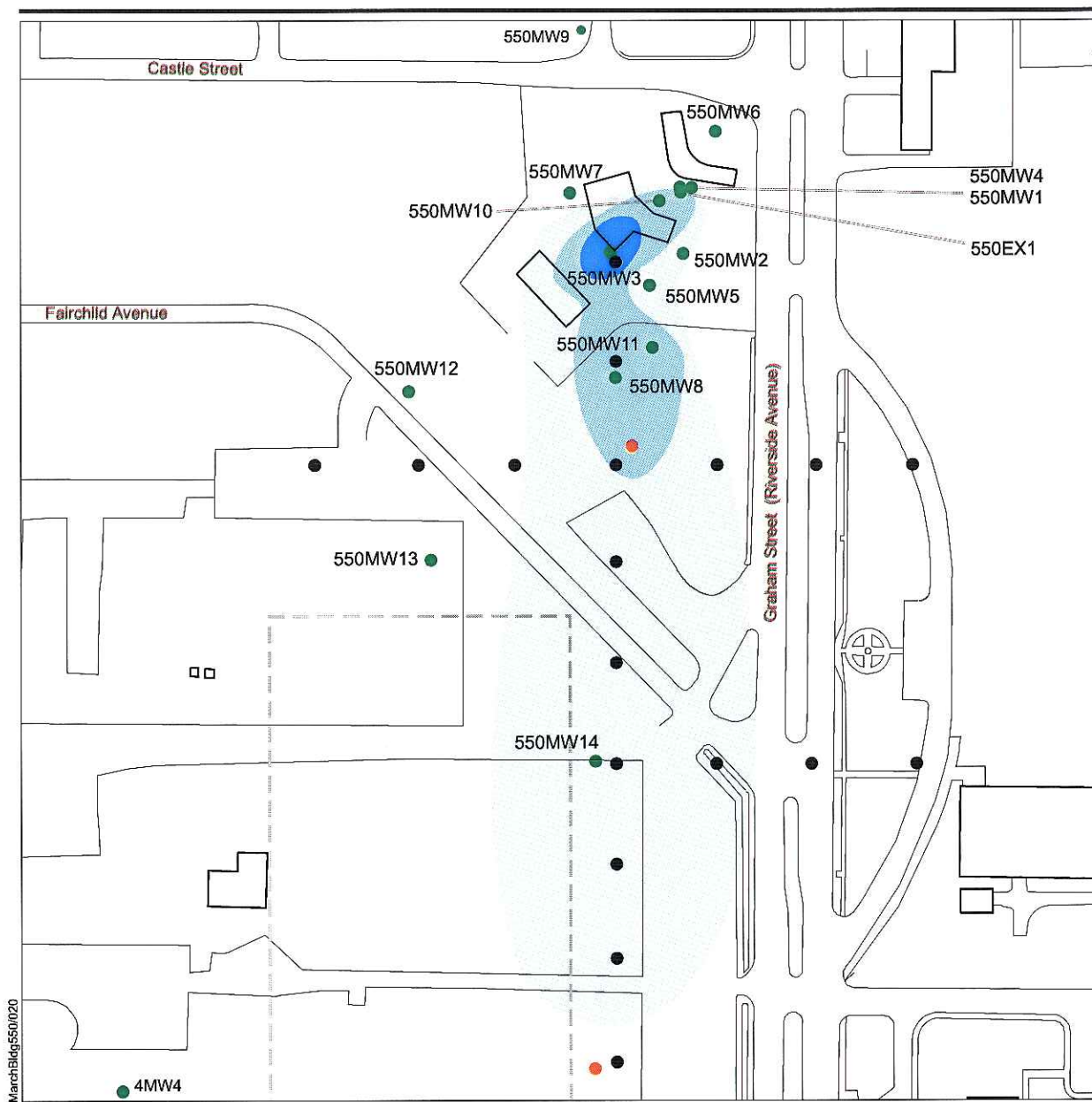
4.2 STAGE II INSTALLATION OF MONITORING, EXTRACTION, AND/OR INJECTION WELLS

During Stage II, hollow stem auger techniques will be used to install extraction and monitoring wells based upon the information obtained during Stage I investigations. Additional soil and groundwater samples will be collected during installation of the extraction well in the source area and groundwater samples collected after installation of the monitoring wells in the downgradient region. All drilling, well installation and development will be in accordance with Section 6 of the Basewide RI/FS work plan (Earth Tech 1999).

4.2.1 Monitoring Wells

Using data collected during Stage I of this RCAWP to identify optimal placement, additional groundwater MWs may be installed. One well will likely be installed in the area of highest concentrations downgradient of the existing MW 550-MW08 as determined by the laboratory data (see Figure 4-2). An additional MW (guardian well) will likely be located downgradient past the leading edge of the existing plume to monitor any further migration of the contaminant plume.

After drilling and sampling of the soil borings are complete, an MW will be constructed in each of the borings using PVC blank casing and stainless steel screen. The MWs screened interval will be based on the analytical data collected during the field investigations. The MWs will be completed in flush-mounted well boxes. The wells will be developed prior to groundwater sampling. Figure 4-3 presents a typical monitoring well.



EXPLANATION

- Monitoring Wells
- Roads
- Buildings
- MTBE Plume > 13 µg/L
- MTBE Plume > 130 µg/L
- MTBE Plume > 1300 µg/L
- Proposed Direct Push Sampling Points
- Proposed Monitoring Wells
- Approximate Location of New Building



Building 550 Proposed Direct Push Locations for Contaminant Plume Characterization Former March Air Force Base, California

Figure 4-2

4.2.2 Extraction Wells

Using data collected during Stage I of this RCAWP to identify optimal placement, additional extraction wells will be installed. One extraction well will be installed within the source area as determined by the laboratory data. An additional extraction well will possibly be installed in a downgradient location to capture the highest contaminated groundwater and prevent further migration of the contaminant plume. These extraction wells will be constructed as either single phase groundwater extraction, single phase vapor extraction, or dual phase (vapor and groundwater extraction) wells. The decision on well type will be determined by lithology, concentrations, and professional judgment base upon the objectives of this workplan.

4.2.2.1 Groundwater Extraction Wells.

Groundwater extraction wells will be constructed of 6-inch diameter, stainless steel wire-wrapped screen with Schedule 80 PVC blank casing to surface. The screened interval will be determined by the Phase I Characterization and will not be placed deeper than the depth of contamination. A typical groundwater extraction well is presented in Figure 4-4. A submersible groundwater extraction pump will be installed in each groundwater extraction well. The pumps will be connected to the existing groundwater treatment system. In addition, a submersible pump will be installed into existing MW 550MW03 (the well with the highest MTBE groundwater concentration).

4.2.2.2 Vapor Extraction Wells.

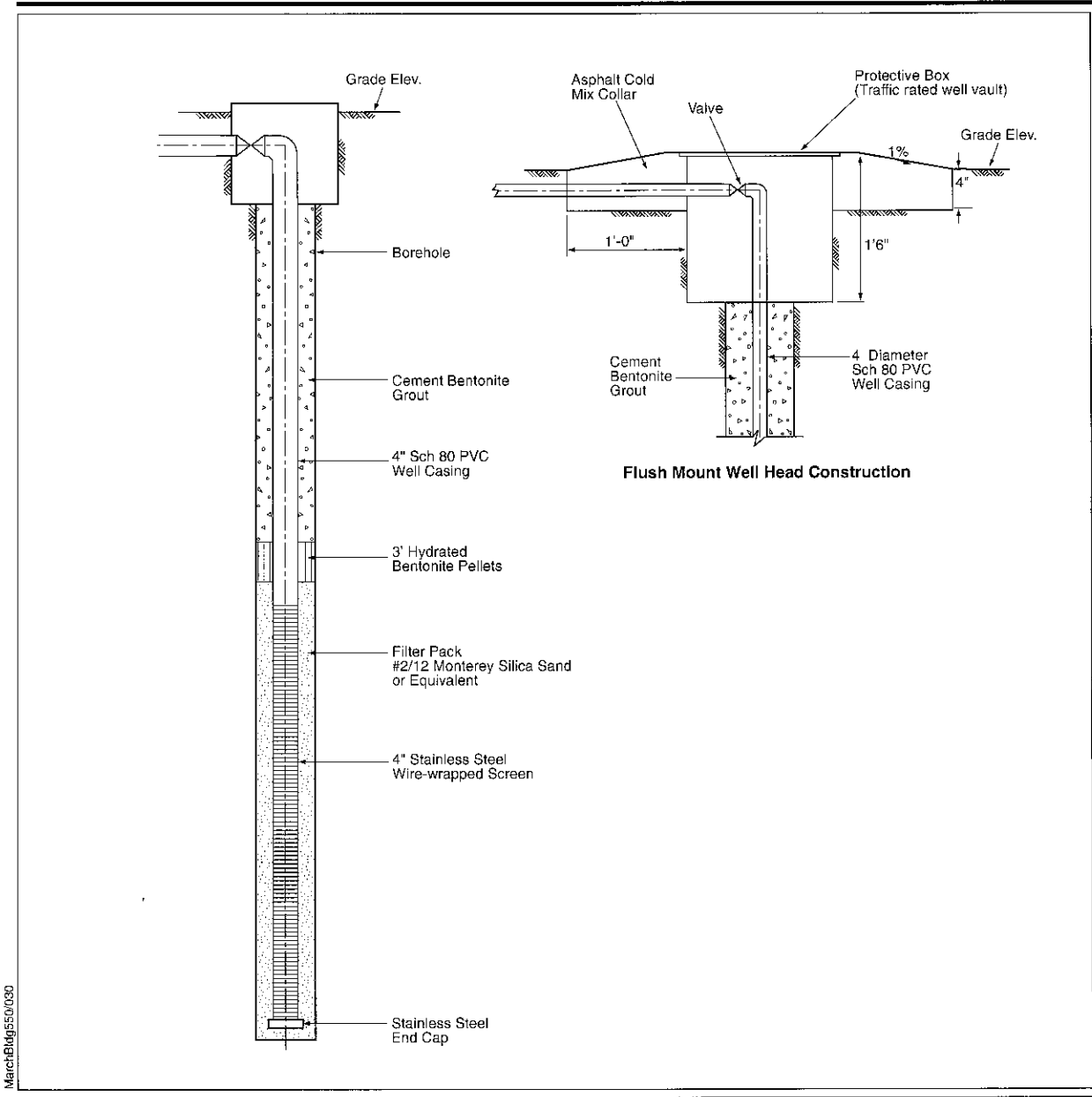
Vapor extraction wells may be installed in the vadose zone in the source area to remove hydrocarbon-laden vapors from the soil. Vapor extraction wells will be constructed of factory slotted 2-inch PVC screens with PVC blank casing to the surface. The screened interval shall be placed based on lithology and contaminant concentrations from the Phase 1 characterization. A typical vapor extraction well is presented in Figure 4-5.

4.2.2.3 Dual Phase Extraction Wells.

Figure 4-6 presents a typical dual phase extraction well design. Two screened intervals; one deep for combined groundwater and soil vapor extraction and one shallow for vapor extraction only, which will be encased within a single borehole. The deep groundwater extraction well will be designed as described in Section 4.2.2.1. The shallow vapor extraction well will be installed in accordance with Section 4.2.2.2. The wells will be separated by a bentonite seal to prevent any cross circulation or short circuiting.

4.2.3 Air Sparge/Ozone Injection/Oxygen Release Compound Injection Wells

The rising water table at the site may have trapped fuel contaminants in soil within the saturated zone. If during the Phase 1 Characterization efforts, soil contamination is reported in the saturated zone, supplementary augmentation or

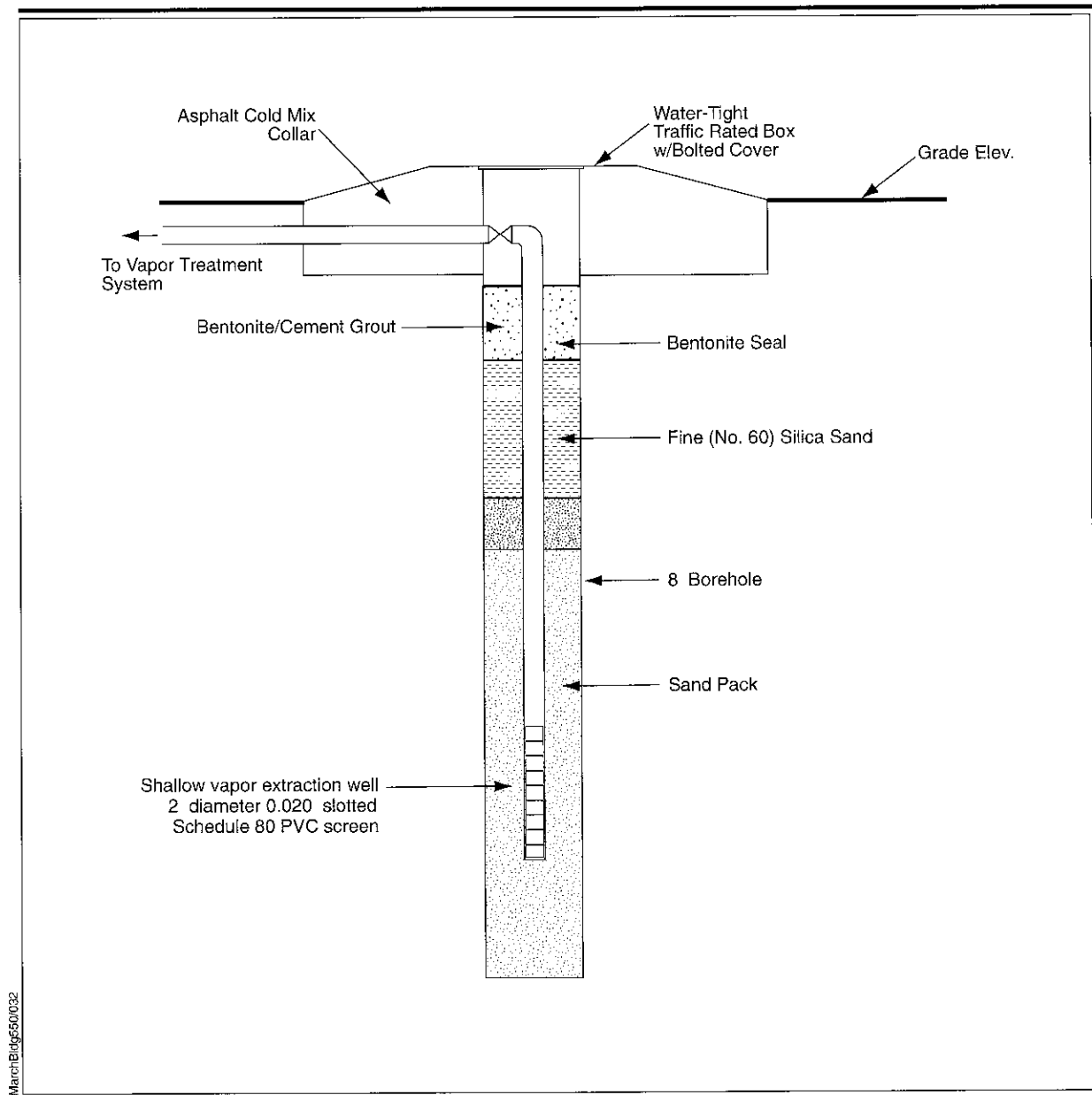


Screen slot size and filter pack grain size may change based on formation.

Typical Groundwater Extraction Well Construction Diagram Former March Air Force Base

Not to Scale

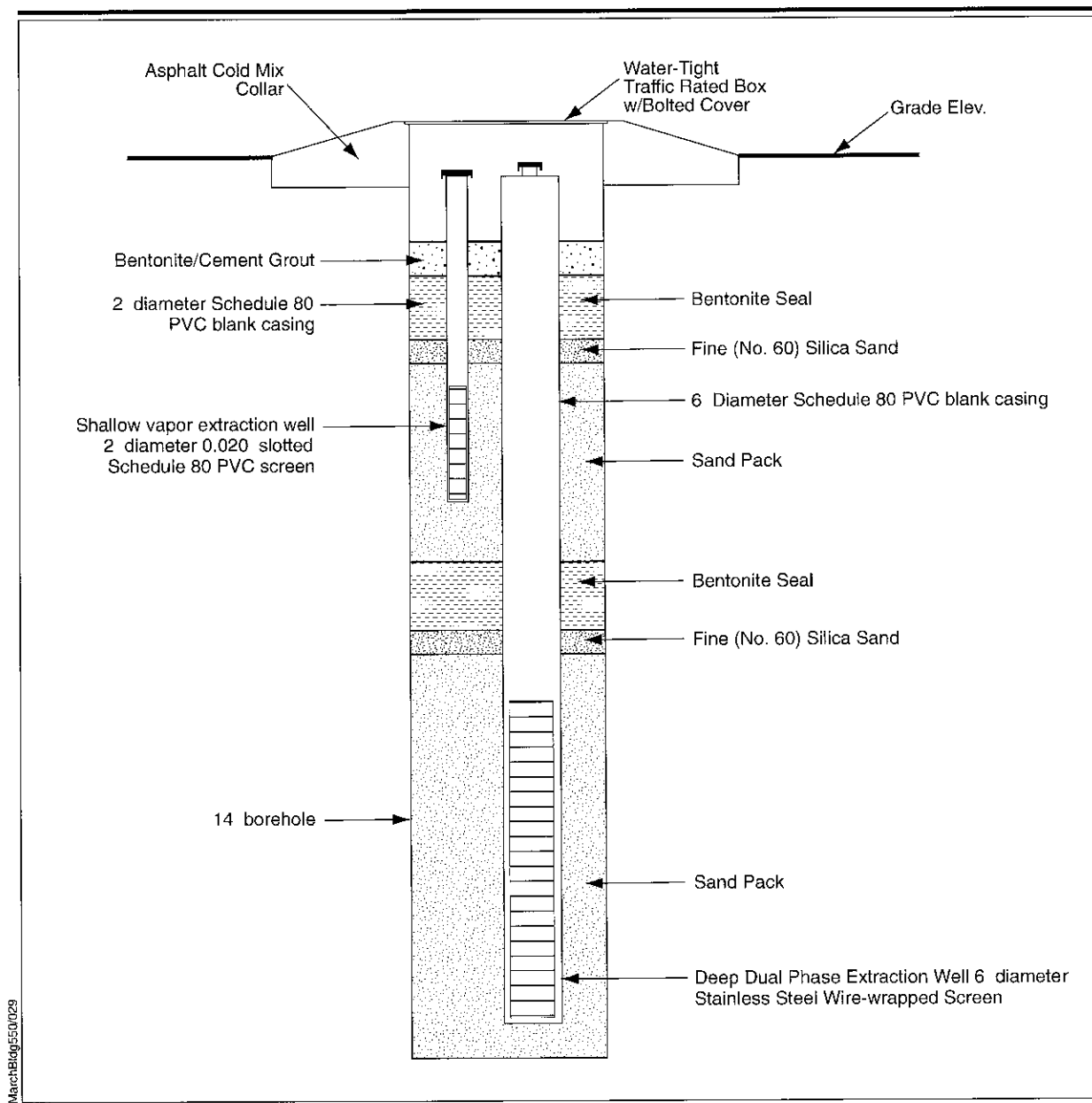
Figure 4-4



**Typical Vapor
Extraction Well
Former March Air
Force Base**

Not to Scale

Figure 4-5



**Typical Dual Phase
Extraction Well
Former March Air
Force Base**

Not to Scale

Figure 4-6

oxidation may be proposed to expedite remediation. One or more injection points consisting of an injection tip connected to the surface by a pipe would be installed in separate boreholes. These injection points would allow for the introduction of oxygen, ozone, or oxygen release compound to be infused directly into the source area. These injection wells would be located around or near the extraction wells. Figure 4-7 presents a typical injection well design.

4.3 SOIL VAPOR EXTRACTION TEST

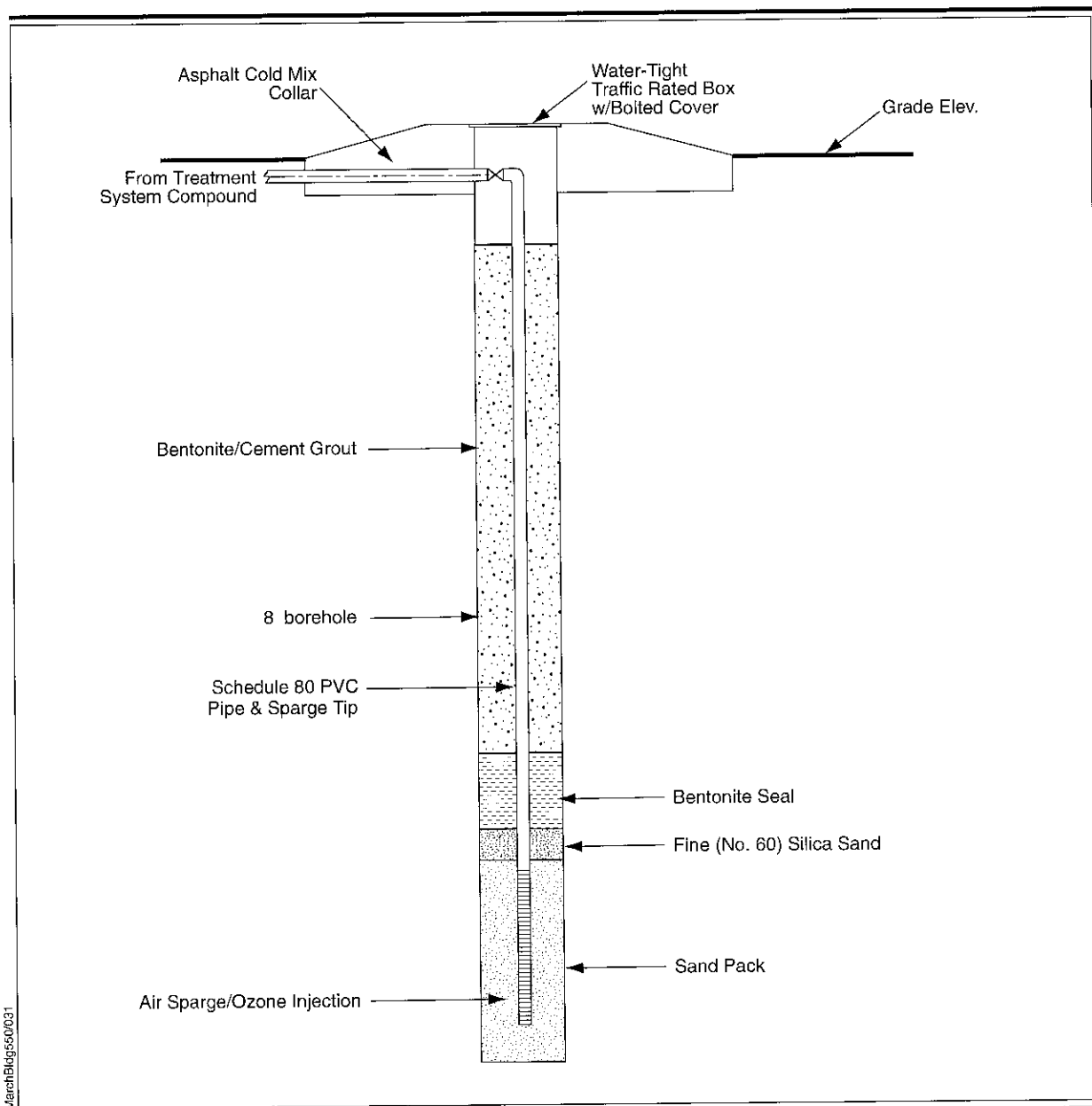
A soil vapor extraction test may be conducted to aid in placement of vapor extraction or dual phase extraction wells to expedite remedial treatment of the soils within the source area. The SVE test will determine flow rates and vacuum radius of influence of new and existing wells and be used to evaluate the current SVE system. The testing will be performed in accordance with the procedures for the approved March Air Force Base IRP Site 27 Soil Vapor Test work plan (Earth Tech 2003c). Previous SVE tests performed recently at various March ARB sites with similar lithology may also be used to determine SVE applicability and parameters.

4.4 MONITORED NATURAL ATTENUATION

After the Phase 1 characterization, data evaluation, and best professional judgment, the "monitored natural attenuation" (MNA) may be considered as the best alternative for this site. MNA evaluation include physical (dispersion, diffusion, dilution by recharge, and volatilization), chemical (sorption and chemical or biotic reactions), or biological (biodegradation) processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater (EPA, 1999). Although cumulatively all of these processes attribute to the MNA to some extent, biodegradation is the primary natural attenuation process occurring in the remaining petroleum-related groundwater contaminant plumes at Building 550. Under favorable field conditions, organic contaminants such as BTEX and MTBE will naturally biodegrade (break down) through microbial activity and ultimately produce non-toxic and harmless end products (carbon dioxide and water). MNA may be considered, depending on the outcome of the Phase I investigation.

4.4.1 Groundwater Extraction System Expansion

The PAT system is currently removing contaminated groundwater from two Extraction Wells: 550-EX01 and 550-MW10. Groundwater sampling results collected in June 2004 indicated MTBE at elevated concentrations of 2,300 µg/l in Well 550MW03 (MWH, 2005a). MTBE concentrations in Well 550-MW03 sampled in June 2004 have nearly doubled from the 1,370 µg/l results reported from the December 2003 sampling round. Installation of a new submersible extraction pump into this well is proposed to further enhance the groundwater extraction rate specifically from the area of greatest MTBE groundwater concentrations. Connection to the PAT system will be with temporary aboveground piping. Piping from this well will be buried pending future system design configuration.



**Typical Sparge Well
Former March Air
Force Base**

Not to Scale

Figure 4-7

The proposed changes will potentially increase the MTBE concentrations at the inlet of the PAT system. Additional treatment may be required prior to discharge to the sewer. Installation of a multi-vessel liquid carbon system (55-gallon drums) or a bioreactor installed in the groundwater process stream following the existing treatment is proposed to deal with the higher levels of MTBE expected from this extraction well.

4.5 PERMITS

All necessary digging permits will be obtained from local agencies and in coordination with the Joint Powers Agency. In addition, Underground Service Alert or Dig Alert will be notified with a request for clearance.

The groundwater treatment system is currently discharging to the sanitary sewer under the March ARB National Pollutant Discharge Elimination System (NPDES) Permit. Additional permit applications will be filed if required (as necessary).

4.6 GEOPHYSICAL CLEARANCE

Geophysical surveys will be used to detect and mark underground utilities before intrusive work is performed. The subsurface utility clearance survey will detect and mark locations of buried man-made objects and geophysical anomalies at areas where intrusive activities will occur such as direct push boring locations, monitoring or extraction well installations, and trenching. The surveys will use ground-penetrating radar (GPR), electromagnetic, and magnetic profiling.

4.7 FIELD MONITORING

Field monitoring consists of measurements performed at the DP locations, existing extraction wells and monitoring wells, with stationary and hand-held instruments. All field data collected will be recorded on field data sheets.

4.8 REPORTING

Earth Tech will prepare field data summary reports documenting the various field operations, analytical data and field results and recommendations for any change in future operations will be reported as well.

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5.0 SAMPLING AND ANALYSIS PLAN

The approved SAP of the IRP Final Work Plan and Quality Project Plan for the Basewide RI/FS March ARB (Earth Tech, 1999) will be used as part of this RCAWP unless otherwise noted. This SAP consists of a Field Sampling Plan (FSP) and a Quality Assurance Project Plan (QAPP).

5.1 FIELD SAMPLING PLAN (FSP)

The field methods and procedures described in the Final Basewide RI/FS FSP (Earth Tech 1999, Section 6.3) are to be referenced, except for sections on DP technologies (CPT and Hydropunch® or equivalents), which are described below. The environmental sampling described in the Final Basewide RI/FS FSP (Earth Tech 1999, Section 6.4) are to be referenced, except for sections on direct reading instruments, soil and groundwater sampling by DP technologies, which are also described in the following sections.

5.1.1 Measurement Objectives

The scope of work is outlined in Section 3.0, and a review of previous studies and existing information may be found in Section 2.0. The overall objective of the RCAWP is to acquire additional data in order to define the extent of soil and groundwater contamination, install additional monitoring points and expand or modify the current remedial treatment system already in-place.

5.1.2 Field Operations

Soil and groundwater samples will be collected and analyzed using multiple methods during this investigation. Geologic information will be obtained using physical sample logging of soil cores and from CPT logs. QC checks will be conducted on a frequent basis as the various investigative techniques are performed. Control checks will include daily laboratory/equipment calibration checks, evaluation of QC samples, and ensuring internal consistency is maintained for all data collected. The following sections briefly discuss the various tasks, procedures, and sample collection techniques performed using direct push technology during the Building 550 investigation.

All soil and groundwater sampling performed during the installation of new extraction and monitoring wells as well as groundwater sampling from existing monitoring and extraction wells will be conducted in accordance with the Basewide RI/FS FSP (Earth Tech 1999).

5.1.3 Direct Push Technology

5.1.3.1 Cone Penetrometer Testing (CPT).

CPT is a method of providing real time data for use in characterizing the subsurface. The method to be used for this investigation will consist of

hydraulically pushing a steel cone into the subsurface using a 30-ton truck. Sensors in the tip and sides of the cone will collect data on pressure and friction in order to determine subsurface lithology. The cone penetrometer will consist of: (1) an enclosed 20- to 40-ton truck equipped with vertical hydraulic rams that are used to force a sensor probe into the ground, (2) data acquisition, processing, and data storage computer system, and (3) electronic signal processing equipment. The cone penetrometer push rods will have a conical tip of up to 2 inches in diameter connected to the leading end. As the rod progresses into the subsurface, a computer will record data from the sensors. The ratio of the cone tip resistance to the sleeve friction will be used to classify the soil type.

For the purposes of this investigation, the CPT will provide continuous, subsurface, screening-quality data; minimize disturbance to the surface and subsurface since no drilling fluids are used and hole diameters are quite small (1 to 2 inches); and allow real-time data analysis so that additional push locations can be selected based upon the results of holes already pushed.

After the CPT push has been completed, the resultant hole will be sealed from its deepest point to the surface with bentonite. The surface location will be recorded in latitude/longitude and California State Plane coordinate systems using a GPS located onboard the CPT vehicle. The SOP for the CPT method is included in Appendix A.

5.1.3.2 Direct Push Groundwater Sampling.

Groundwater sampling collected in conjunction with DP technologies will be conducted using a Hydropunch® type groundwater sampler. The groundwater sampler has a retrievable stainless steel or disposable PVC screen with steel drop-off tip. This will allow for groundwater samples to be taken at multiple depth intervals within the same sounding location. Some groundwater samples may be collected from existing monitoring wells within the site boundaries.

The groundwater sampler will be advanced with the same truck used for CPT activities. Total depth of advancement will be at approximately the point of first water, or approximately 2 to 3 feet below the actual potentiometric surface. Once at the desired sample depth, the push rods will be retracted to expose the encased filter screen (either PVC or stainless steel). Groundwater will be allowed to infiltrate hydrostatically from the formation into the inlet screen. A small diameter bailer approximately 1/2 or 3/4 inches in size will be lowered through the push rods into the screen section for sample collection. The sample collection time will be largely a function of the yield characteristics and storage capacity of the water-bearing formation. Upon completion of sample collection, the push rods and sampler, with the exception of the PVC screen and steel expendable drive tip, will be retrieved to the ground surface, decontaminated using standard procedures, and prepared for the next sampling event. After sampling has been completed, the hole will be sealed from its deepest point to the surface with bentonite. The SOP for collection of groundwater samples using Hydropunch® methods is included in Appendix A.

After collection, the samples will be analyzed for VOCs, including BTEX, and fuel oxygenates MTBE using EPA Methods 8260 in an on-site laboratory. Approximately 10 percent of the total number of samples collected will be sent to an off-site laboratory for analysis using EPA Methods 8260 and Mod 8015. This will help to ensure the quality and usability of the data obtained from the on-site laboratory. Samples may also be analyzed for geochemistry parameters and microbial information at the off-site laboratory. Analytical methods both on site and off site are discussed below.

5.1.3.3 Direct Push Soil Sampling.

Soil samples may be collected at locations and depths determined by historical and concurrent field laboratory results. Using DP technology or if necessary, a hollow stem auger, soil will be collected in 1" x 6" stainless steel sleeves. After retrieval, the ends of each sleeve will be visually examined for staining or discoloration. In addition, a PID will be used to screen each sample for VOCs. The site engineer/geologist will select the samples to be analyzed based on the visual evidence of staining and/or highest PID results to determine which of the samples will be analyzed by the off-site laboratory. The sample sleeve will be removed from the coring device, the ends covered with Teflon squares, capped with plastic end covers to preserve any VOCs that may be contained in the soil. Each sampler will be labeled and placed into an ice-filled cooler for shipment to the off-site laboratory. Two (2) 1" x 6" stainless steel sleeves will be collected from each sample interval. These selected soil samples will be analyzed for the VOCs using EPA Method 8260B. After sampling has been completed, the hole will be sealed from its deepest point to the surface with bentonite or cement-bentonite grout.

5.2 ANALYTICAL METHODS

This section presents the various aspects of the sampling methodology to be employed during the Building 550 RCAWP investigation. Sampling locations, frequency, matrix, and analytical methods are discussed below. The sampling plan for Building 550 will follow the AFCEE QAPP version 3.1 (AFCEE, 2001), the RI/FS (Earth Tech, 1999) or the *Corrective Measures Implementation Work Plan Building 550* (Earth Tech 2003c) unless noted otherwise. Chemical methods and analysis to be performed on the soil, and groundwater samples collected are listed in Table 5-1. SOPs for water analyses using U.S. EPA Methods 8260B for the on-site laboratory are included in Appendix B.

5.3 SAMPLE IDENTIFICATION AND LABELING

Samples will be assigned a specific identification (ID) to uniquely represent each sample and be recorded on the sample container itself, as well as the chain-of-custody (CoC) form, field logbook, and other project records. The sample ID will also associate the sample with the study site. The sampling ID assignment method is provided below:

Table 5-1. Laboratory - Chemical Methods and Analysis for Soil and Water Samples

Analysis	Method Number	Sample Matrix
On-Site Laboratory		
Volatile Organic Compounds	EPA SW-846, Method 8260	Water
Off-Site Laboratory		
Volatile Organic Compounds	EPA Method 8260B	Soil and water
TPHg	EPA SW846 Method 8015B	Soil and water

EPA = Environmental Protection Agency

General Form: March-550-@@##-AA###-###

Where

550 = for Building 550

Sampling Location

@@ = 'CP' for cone penetration test point number

= 'SB' for soil boring

= 'MW' for monitoring well

= 'EW' for extraction well

= consecutively numbered sampling locations

Sample matrix or type

AA = 'GW' for groundwater sample

= 'SS' for soil sample

= 'TB' for trip blanks

= 'EB' for equipment blanks or field rinsate blanks

= consecutively numbered samples at each sampling location

= 001-099 for normal samples

= 201-299 for duplicate samples

Sample Collection Depth

= sample depth

As an example, the first groundwater sample collected from a CPT hole at the first designated sampling location and from 35 feet bgs would be designated as 550-CP01-GW001-035. A soil sample collected from a soil boring at the 25th designated sampling location and 15 feet bgs would be designated as 550-SB25-SS001-015. The duplicate soil sample at the same location and depth would be labeled with an ID of 550-SB25-SS201-015. An equipment blank collected at the end of the sampling day would be designated as 550-EB01, EB02, etc. A trip blank would be identified with the ID of 550-TB01, 550-TB02, and etc.

Matrix spike/matrix spike duplicate (MS/MSD) samples will not be designated in the sample numbering system. The sample to be used for MS/MSD will be identified in the remarks section of the chain of custody form.

Pre-printed sample labels will be used to identify each sample container and will contain the following information:

- Project Number
- Sample ID
- Sample Date
- Sample Time
- Container Type
- Preservative
- Analyses to be performed
- Name of sampling personnel.

Samples will be sent to the analytical laboratories in sample delivery groups (SDGs). Each SDG will consist of field samples collected, field/rinsate blanks, duplicates of primary samples, MS/MSD designated samples, and trip blanks.

5.4 SAMPLE PRESERVATION AND HANDLING

This section describes the methods and techniques used to handle and preserve samples, once they are collected, and includes descriptions of sample containers, preservation techniques, and storage requirements.

5.4.1 Sample Containers

Sample containers will consist of stainless steel sleeves for all soil analysis; 40 ml volatile organic analysis (VOA) glass vials for groundwater VOC and TPHg analysis. The containers will be pre-cleaned and certified by the contract laboratory, with documentation recording the batch numbers for the containers, where applicable.

5.4.2 Sample Preservation

Sample preservatives are used to maintain the original character of analytes during storage and shipment. Prior to shipping sample containers to the field, the laboratory will add the required preservatives to the sample bottles that will be used for groundwater samples and rinsate blanks. Each container with preservative will have a label that identifies the type and amount of preservative.

Sample labels will be affixed to all sample containers and will clearly display the sample identification number along with the collection time and date. Samples will be placed in the appropriate sample container and placed in an ice-filled cooler immediately upon sample collection. For on-site analysis, all samples will be immediately transferred to the on-site mobile laboratory. For off-site analysis, all samples will be shipped daily.

For the off-site laboratory, the samples will be placed in plastic bags, and wrapped and cushioned in inert packing material such as closed-cell foam or bubble wrap. Samples and COC forms will be shipped in coolers packed with ice to assure the proper temperature. Custody seals will be affixed to the outside of the sealed coolers prior to shipment. Logbooks will contain a record of all sample collection

locations, time, and other pertinent observations, and will serve as the permanent record of all sample collection activities.

5.4.3 Sample Storage

Samples will remain in the possession of the sampling personnel or placed in secure storage until they are shipped or delivered to either the off-site or on-site laboratory. Empty, hard plastic coolers containing ice or ice substitute will be made available for all site sampling personnel on a daily basis, sufficient to hold all of the samples expected to be collected during a given day. The coolers will be supplied by the respective laboratory and adequately cleaned to prevent potential cross-contamination. As samples are collected, they will immediately be placed in an ice-filled cooler such that the temperature is maintained at approximately 4 degrees Celsius ($^{\circ}\text{C}$). Ice or an ice substitute will be replenished as needed to ensure adequate cooling of samples during storage and transportation to the laboratory. The hard plastic coolers used for storing the samples will also be used for shipping the samples to the off-site laboratory.

5.5 QUALITY CONTROL SAMPLES

QC samples will be collected as part of the overall QC plan. These samples will be used to establish the validity of the data derived from analytical processes. Sample types for QC use are discussed in the following sections. The frequency of collection of each QC sample discussed below is shown in Table 5-2.

Table 5-2. Quality Control Samples and Frequency

Analysis	QC Sample	Frequency
Groundwater		
8015B TPHg and 8260B VOCs		
	Field Duplicate	1 for each 10 samples
	Equipment Blank (if necessary)	At least 1 per day
	Trip Blank	1 for each cooler (only for off-site laboratory shipments)
	MS/MSD	1 for each 20 samples
Soil		
8015B TRPH and 8260B VOCs		
	Field Duplicate	1 for each 10 samples
	Equipment Blank (if necessary)	1 for each day
	Trip Blank	1 for each cooler (only for off-site laboratory shipments)
	MS/MSD	1 for each 20 samples

MS/MSD = matrix spike/matrix spike duplicate
 PE = performance evaluation
 VOCs = volatile organic compounds

5.6 EQUIPMENT DECONTAMINATION

See Section 6.5.4 Basewide RI/FS FSP (Earth Tech, 1999)

Sampling equipment will be cleaned and decontaminated before each sample is collected, or used once and disposed of if the equipment is of the disposable type. Reusable equipment will be decontaminated with detergent wash, rinsed with clean water, rinsed again with deionized (DI) water. Sampling equipment that will not be used immediately following decontamination will be wrapped in aluminum foil.

5.7 LABORATORY ANALYTICAL PROCEDURES

VOCs and fuel compounds in water samples will be analyzed using Method SW820B in the on-site laboratory. Ten percent of these samples will be sent to the off-site laboratory for analysis of VOCs using U.S. EPA SW-846 Method SW8260B (soil and water) and TPHg using Mod 8015 Method.

5.8 QUALITY ASSURANCE PROJECT PLAN (QAPP)

The QAPP presents the QA/QC requirements designed to achieve the data quality goals described in the FSP. This QAPP is required reading for all staff participating in the work effort. The QAPP shall be in the possession of the field teams and the laboratories performing the work.

5.8.1 Quality Assurance Guidance

Analytical QA/QC for samples analyzed on-site will be performed by sending 10 percent of the samples for fixed laboratory analysis. Off-site analytical QA/QC will be performed in accordance with the following guidance and technical specifications:

- *AFCEE QAPP*, Version 3.1 (AFCEE, 2001), unless otherwise noted
- *Installation Restoration Program (IRP) Final Work Plan and Quality Project Plan for the Basewide Remedial Investigation/Feasibility Study (RI/FS) March Air Reserve Base* (Earth Tech, 1999)
- Quality Assurance Project Plan Variances and Additions to the March ARB QAPP (Appendix D)
- QA/QC for the on-site laboratory will include the introduction of PE samples into the sample stream to determine the accuracy of the on-site laboratory.
- *Corrective Measures Implementation Work Plan Building 550, March ARB, California*, (Earth Tech, 2003a).

5.8.2 Method Detection Limits

The method detection limit (MDL) is the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero. The laboratory shall establish MDLs for each method, matrix, and analyte for each instrument the laboratory plans to use for the project. The laboratory shall revalidate these MDLs at least once per 12-month period. The laboratory shall provide the MDL demonstrations to Earth Tech at the beginning of the project upon request.

Laboratories participating in this work effort shall demonstrate the MDLs for each instrument, including confirmatory columns, method of analysis, analyte, and matrix (i.e., water, and soil) using the instructions listed in the AFCEE QAPP (AFCEE, 2001).

5.8.3 Reporting Limits

Both on-site and off-site laboratories participating in this work effort shall compare the results of the MDL demonstrations to the reporting limits (RLs) for each method that is used. The MDL may not be more than one-half the corresponding RL. The laboratories shall also verify RLs by including a standard at or below the RL as the lowest point on the calibration curve. All results shall be reported at or above the MDL values; however, for those results falling between the MDL and the RL, a qualifier shall be applied to the results indicating the variability associated with the result. No results shall be reported below the MDL. Reporting limits for the analytical methods to be used for this project are listed in Table 5-3.

5.8.4 Instrument Calibration

Analytical instruments shall be calibrated in accordance with the analytical methods. All analytes reported shall be present in the initial and continuing calibrations, and these calibrations shall meet the acceptance criteria. All results reported shall be within the calibration range. Results outside the calibration range are unsuitable for quantitative work, and will only give an estimate of the true concentration. All calibration criteria shall satisfy SW-846 requirements at a minimum. Additional information and instructions for instrument calibration can be found in the AFCEE QAPP (AFCEE, 2001).

5.8.5 Elements of Quality Control

The type of QC samples and the frequency of use of these samples are discussed in the AFCEE QAPP (AFCEE, 2001). Control limits and spiking compounds for EPA Method SW-8260B for the soil and water samples and 8015B collected for this project and for surrogate spike samples in the laboratory are listed in Tables 5-4 and 5-5, respectively.

Table 5-3. Off-site Laboratory Reporting Limits For VOCs
(Page 1 of 2)

Parameter	Method S=Soil, W=Water	Analyte	Water (µg/l)	Soil (mg/kg)
TPHg	SW8015B (S,W)	Gasoline	1	1
VOCs	SW8260B (S,W)	1,1,1,2-Tetrachloroethane	1	5
		1,1,1-Trichloroethane	1	5
		1,1,2,2-Tetrachloroethane	1	5
		1,1,2-Trichloroethane	1	5
		1,1-Dichloroethane	1	5
		1,1-Dichloroethene	1	5
		1,1-Dichloropropene	1	5
		1,2,3-Trichlorobenzene	1	5
		1,2,3-Trichloropropane	1	5
		1,2,4-Trichlorobenzene	1	5
		1,2,4-Trimethylbenzene	1	5
		1,2-Dibromo-3-chloropropane	1	5
		1,2-Dibromoethane	1	5
		1,2-Dichlorobenzene	1	5
		1,2-Dichloroethane	1	5
		1,2-Dichloropropane	1	5
		1,3,5-Trimethylbenzene	1	5
		1,3-Dichlorobenzene	1	5
		1,3-Dichloropropane	1	5
		1,4-Dichlorobenzene	1	5
		2,2-Dichloropropane	1	5
		2-Chlorotoluene	1	5
		4-Chlorotoluene	1	5
		Benzene	0.5	5
		Bromobenzene	1	5
		Bromochloromethane	1	5
		Bromodichloromethane	1	5
		Bromoform	1	5
		Bromomethane	1	5
		Carbon Tetrachloride	0.5	5
		Chlorobenzene	1	5
		Chloroethane	1	5
		Chloroform	1	5
		Chloromethane	1	5
		cis-1,2-Dichloroethene	0.5	5
		cis-1,3-Dichloropropene	0.5	5
		Dibromochloromethane	1	5
		Dibromomethane	1	5
		Dichlorodifluoromethane	1	5
		Ethylbenzene	0.5	5
		Hexachlorobutadiene	1	5
		Isopropylbenzene	1	5

Table 5-3. Off-site Laboratory Reporting Limits For VOCs
(Page 2 of 2)

Parameter	Method S=Soil, W=Water	Analyte	Water (µg/l)	Soil (mg/kg)
VOCs (Continued)	SW8260B (S,W)	m,p-Xylene	1	5
		Methylene Chloride	1	5
		Naphthalene	1	5
		n-Butylbenzene	1	5
		n-Propylbenzene	1	5
		o-Xylene	0.5	5
		p-Isopropyltoluene	1	5
		sec-Butylbenzene	1	5
		Styrene	1	5
		tert-Butylbenzene	1	5
		Tetrachloroethene	1	5
		Toluene	0.5	5
		trans-1,2-Dichloroethene	1	5
		trans-1,3-Dichloropropene	1	5
		Trichloroethene	1	5
		Trichlorofluoromethane	1	5
		Vinyl Chloride	0.5	5
		MTBE	1	5

Note: (a) Not applicable for Method 8021, See Appendix A
µg/l = micrograms per liter MTBE = methyl tertiary butyl ether
mg/kg = milligrams per kilogram VOC = volatile organic compound

Table 5-4. Control Limits for Laboratory Control Samples for Soil and Water

Analytical Method	Spiking Compounds	Spike Concentration (LCS)		Final Spike Concentration (MS/MSD)		Laboratory Established Control Limits	
		Water (µg/l)	Soil/ Sediments (mg/kg)	Water (µg/l)	Soil/ Sediments (mg/kg)	Percent Recovery (%)	
						Water	Soil/ Sediments
SW8015B	Gasoline	1.0 mg/L	1.0	1.0 mg/L	1.0	65-135	65-135
SW8260B	1,1-Dichloroethene	10	0.05	10	0.05	75-125	65-135
	Benzene	10	0.05	10	0.05	75-125	65-135
	Chlorobenzene	10	0.05	10	0.05	75-125	65-135
	Toluene	10	0.05	10	0.05	74-125	64-135
	Trichloroethene	10	0.05	10	0.05	75-125	65-135

Note: (1) Acceptance limits for MS/MSD are 80-120
Spiked matrix/duplicate pairs that exceed this limit are either re-analyzed or a matrix blank is spiked (Lab Control Spike) to check method performance.
LCS = laboratory control sample
µg/l = micrograms per liter
mg/kg = milligrams per kilogram
MS/MSD = matrix spike/matrix spike duplicate

Table 5-5. Laboratory Control Limits for Surrogate Spikes

Analytical Method	Final Spike Concentration			Laboratory-Established Control Limits	
				Percent Recovery (%)	
	Spiking Compounds	Water (µg/l)	Soil/ Sediments (mg/kg)	Water	Soil/ Sediments
SW8015B	Surrogates:				
Gasoline/BTEX	Chlorobenzene	20	0.020	70-130	70-130
SW8260B	Surrogates:				
	1,2-Dichloroethane-d4	10	0.05	75-120	65-135
	Toluene-d8	10	0.05	80-120	75-125
	4-Bromofluorobenzene	10	0.05	75-120	75-125
	Dibromofluoromethane	10	2.5	80-120	65-135

Note: Samples whose surrogate exceeds the limits are re-analyzed one time.
 µg/l = micrograms per liter
 mg/kg = milligrams per kilogram

5.9 QUALITY CONTROL PROCEDURES

QC procedures, including holding time compliance, confirmation, and standard materials are discussed in the AFCEE QAPP (AFCEE, 2001).

5.10 DATA REDUCTION, VALIDATION, AND REPORTING

5.10.1 Data Reduction

Laboratory data reduction and verification procedures are required to ensure the overall objectives of analysis and reporting meet method and project specifications. Resultant data from chemical analyses will be checked for completeness and reasonableness. Accuracy will be continuously monitored by the laboratory. Earth Tech will place all data into spreadsheets or computerized databases for the purpose of data analysis and summarization. Earth Tech may also use the data to create logs, maps, or other appropriate tools for analysis of the data.

5.10.2 Data Validation

Data validation will be accomplished by Earth Tech by reviewing the data provided by both laboratories and either accepting, rejecting, or qualifying it on the basis of established criteria. Data from groundwater and soil sampling will be validated at a rate of 10 percent for all raw data, and 90 percent of all QC summaries. Validation criteria include holding times, instrument calibration, and QC results. Data will be validated according to the procedures and guidance given in the AFCEE QAPP (AFCEE, 2001).

5.10.3 Data Reporting

Data reporting by the laboratories will include results from both initial and continuing calibration, blanks, duplicates, MS/MSDs, and other data where applicable. Backup data such as chromatograms will be presented with the data

when requested, usually for 10 percent of the data. A careful review of the data reports and associated data will be made by the project QA/QC manager.

Earth Tech will report final validated data to the Air Force in the investigation report.

6.0 REFERENCES

- Air Force Center for Environmental Excellence (AFCEE), 2001. *Quality Assurance Project Plan (QAPP)*, Version 3.1. August.
- CKY, Inc., 1997. *Final Report: Preliminary Soil and Groundwater Quality Assessments, Building 550-Former Exchange Service Station, March Air Force Base, California*. January.
- Earth Tech, 1999. *Installation Restoration Program (IRP) Final Work Plan and Quality Project Plan for the Basewide Remedial Investigation/Feasibility Study, March Air Reserve Base, California*. March.
- 2002. *March ARB Sites 2 and 27 Treatability Implementation Plan, March ARB, California*. August.
- 2003a. *Corrective Measures Implementation Work Plan Building 550, March ARB, California*. May.
- 2003b. *Health and Safety Plan for Operation and Maintenance of Soil Vapor and Groundwater Extraction Systems at Building 550, March ARB, California*. January.
- 2003c. *Letter Work Plan for a Soil Vapor Extraction Test at IRP Site 27, 550, March ARB, California*. March.
- 2006. 2nd Semiannual 2005 Process Monitoring Report July 2005 through December 2005 Groundwater Treatment System Building 550, Former March AFB, California. Forthcoming
- Environmental Protection Agency, 1999. *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites*. United States Environmental Protection Agency, Washington, D.C., Office of Solid Waste and Emergency Response, Directive Number 9200.4-17P. April.
- Montgomery Watson (MWH), 2000. *Final Quality Program Plan, Long-term Groundwater Monitoring, Long-term Operation, and Long-term Operation and Maintenance Program, March ARB, California*. September.
- 2004. *Final Revised Quality Program Plan, Long-term Groundwater Monitoring, Long-term Operation, and Long-term Operation and Maintenance Program, March ARB, California*. June.
- 2005a. *Annual Monitoring Report, Building 550, Groundwater Monitoring Program, March ARB, California*. March.
- 2005b. *Fourth Quarter 2004 and First Quarter 2005 Long-Term Groundwater Monitoring Informal Technical Information Report AFRC and AFRPA Groundwater Monitoring Programs, March ARB, California*. May.
- Tetra Tech, Inc., 1999a. *Report of Field Investigation Activities, Building 550, Site 12A, March Air Force Base, California*. September.
- 1999b. *Draft Report of SVE Pilot Study at Building 550, Site 12A, March Air Force Base, California*. November.
- 2001. *Draft Final Work Plan Addendum, Groundwater Treatment Pilot Study for Operable Unit 2, Building 550, March Air Force Base, California*. May.

- 2002. *Process Monitoring Report, June 2002-August 2002, Soil Vapor and Groundwater Extraction and Treatment Systems, Building 550, March Air Force Base, California.* October.
- 2005. *Draft Semiannual 2005 Process Monitoring Report July 2005 through December 2005 Groundwater Treatment System Building 550, Former March AFB, California.* March.


APPENDIX A

WELL CONSTRUCTION AND BOREHOLE LOGS





SOIL BORING LOGS

BORING LOCATION		ELEVATION AND DATUM		Measured from Ground Level (GL)	
DRILLING AGENCY/ DRILLER	A & R Drilling, Inc. / Barry	DATE STARTED	6/19/96	DATE FINISHED	6/19/96
DRILLING EQUIPMENT	CME 75 / 3-1/4" ID Hollowstem	COMPLETION DEPTH (ft)	45'	DEPTH TO BEDROCK (ft)	NA
HAMMER WEIGHT/ DROP DISTANCE	140 lbs. / 30"	DIAMETER OF BORING (in.)	6"	DIAMETER OF WELL (in.)	NA
TYPE OF WELL CASING	NA	SCREEN PERFORATION	NA	SCREEN INTERVAL (ft)	NA
TYPE/SIZE OF FILTER PACK	NA	TYPE/THICKNESS OF SEALS	Backfilled with Cement/Bentonite Grout		
WATER DEPTH (ft)	Not Encountered	LOGGED BY	TF	CHECKED BY	VJ

TIME	PID (ppm)	BLOW COUNT (per foot)	SAMPLE NUMBER	SAMPLE INTERVAL	DEPTH (ft)	LITHOLOGY	WELL CONSTRUCTION	DESCRIPTION OF SUBSURFACE MATERIALS
1045	110	38/42/50	1					Approx. 2.5" concrete
1052	130	24/38/50	2		5			Sandy SILT (ML): very fine, slightly moist, slightly plastic, brown, hard
1102	371	16/17/20	3		10			Silty SAND (SM): slightly moist, very dense with clay, gray
1110	144	8/18/27	4		15			Sandy SILT (ML): slightly moist, fine sand, hard, gray
1117	60	12/17/19	5		20			moist, increased sand content, very stiff, gray
1130	5	24/38/50	6		25			slight plasticity
					30			Silty SAND (SM): fine to medium grains, very dense, brown, partially gray (stain?)

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LOG OF BORING NO. B-1

TIME	PID (ppm)	BLOW COUNT (per foot)	SAMPLE NUMBER	SAMPLE INTERVAL	DEPTH (ft)	LITHOLOGY	WELL CONSTRUCTION	DESCRIPTION OF SUBSURFACE MATERIALS
1142	5.8	30/38/50	7					Silty SAND (SM): fine to medium, slight plasticity, gray, very dense
1150	1.7	26/32/50	8		35			dense, brown & gray
1156	55	28/42/50	9		40			very dense, gray
1211	45	15/19/40	10		45			Sandy Silt (ML): mica, moist, gray, hard Boring terminated at 45'
					50			
					55			
					60			
					65			
					70			



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Project No.:
9560

LOG OF BORING NO. B-1

BORING LOCATION	4' Northwest of UST excavation near BLD 549	ELEVATION AND DATUM	Measured from Ground Level (GL)	
DRILLING AGENCY/DRILLER	A & R Drilling, Inc. / Barry	DATE STARTED	6/18/96	DATE FINISHED 6/18/96
DRILLING EQUIPMENT	CME 75 / 3-1/4" ID Hollowstem	COMPLETION DEPTH (ft)	45'	DEPTH TO BEDROCK (ft) NA
HAMMER WEIGHT/DROP DISTANCE	140 lbs. / 30"	DIAMETER OF BORING (in.)	6"	DIAMETER OF WELL (in.) NA
TYPE OF WELL CASING	NA	SCREEN PERFORATION	NA	SCREEN INTERVAL (ft) NA
TYPE/SIZE OF FILTER PACK	NA	TYPE/THICKNESS OF SEALS	Backfilled with Cement/Bentonite Grout	
WATER DEPTH (ft)	Not Encountered	LOGGED BY	TF	CHECKED BY VJ

TIME	PID (ppm)	BLOW COUNT (per foot)	SAMPLE NUMBER	SAMPLE INTERVAL	DEPTH (ft)	LITHOLOGY	WELL CONSTRUCTION	DESCRIPTION OF SUBSURFACE MATERIALS
0920								2" to 3" of concrete
0927	2.6	2/3/13	1					Silty SAND (SM): brown, moist, fine to medium, medium dense, trace clay, low plasticity
0932	2.0	22/32/35	2		5			trace coarse sand, decreased clay, very dense
0945	59.7	16/26/28	3		10			Sandy SILT (ML): olive gray, slightly moist, hard, with fine sand, trace mica, slight hydrocarbon odor
0950	416	12/24/40	4		15			continued hydrocarbon odor, decreased silt content
1000	639	9/12/22	5		20			continued odor
1008	405	21/28/36	6		25			3" clayey medium to coarse sand layer, continued odor
					30			Clayey SAND (SC): brown to olive, slightly moist to moist, medium to coarse, dense, medium plasticity, slight hydrocarbon odor



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Project No.:
9560

LOG OF BORING NO. B-2

TIME	PID (ppm)	BLOW COUNT (per foot)	SAMPLE NUMBER	SAMPLE INTERVAL	DEPTH (ft)	LITHOLOGY	WELL CONSTRUCTION	DESCRIPTION OF SUBSURFACE MATERIALS
1030	220	29/50 for 6"	7					Clayey SAND (SC): brown to olive, slightly moist to moist, medium to coarse, very dense, medium plasticity, slight hydrocarbon odor.
1040	192	29/38/42	8		35			Silty SAND (SM): brown, fine, slightly moist, very dense, with mica, slight hydrocarbon odor
1051	9,570	17/27/30	9		40			dense, slight odor
								increased silt content, increased mica, very dense, slight odor
1101	5,900	17/28/45	10		45			Boring terminated at 45'
					50			
					55			
					60			
					65			
					70			



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Project No.:
9560

LOG OF BORING NO. B-2

BORING LOCATION	28' Southwest of the former UST excavation	ELEVATION AND DATUM	Measured from Ground Level (GL)	
DRILLING AGENCY/DRILLER	A & R Drilling, Inc. / Barry	DATE STARTED	6/18/96	DATE FINISHED 6/18/96
DRILLING EQUIPMENT	CME 75 / 3-1/4" ID Hollowstem	COMPLETION DEPTH (ft)	45'	DEPTH TO BEDROCK (ft) NA
HAMMER WEIGHT/DROP DISTANCE	140 lbs. / 30"	DIAMETER OF BORING (in.)	6"	DIAMETER OF WELL (in.) NA
TYPE OF WELL CASING	NA	SCREEN PERFORATION	NA	SCREEN INTERVAL (ft) NA
TYPE/SIZE OF FILTER PACK	NA	TYPE/THICKNESS OF SEALS	Backfilled with Cement/Bentonite Grout	
WATER DEPTH (ft)	Not Encountered	LOGGED BY	TF	CHECKED BY VJ

TIME	PID (ppm)	BLOW COUNT (per foot)	SAMPLE NUMBER	SAMPLE INTERVAL	DEPTH (ft)	LITHOLOGY	WELL CONSTRUCTION	DESCRIPTION OF SUBSURFACE MATERIALS
1314	2,970	3/14/17	1					3.5" to 4" asphalt
								Clayey SAND(SC): red brown, fine, slightly moist, medium, medium dense
1323	676	38/50 for 5"	2		5			Silty Sand (SM): red brown, fine, slightly moist, very dense, trace mica, trace clay
1333	8,540	45/42/38	3		10			with coarse sand
1341	38.6	16/26/46	4		15			brown
1355	34.6	20/20/40	5		20			
1430	47.6	20/46/50 for 5"	6		25			Sandy SILT (ML): brown, slightly moist, hard, with clay
					30			

CKY CKY incorporated
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Project Name:
AFCEE D.O.I / MAFB-550

Project No.:
9560

LOG OF BORING NO. B-3

TIME	PID (ppm)	BLOW COUNT (per foot)	SAMPLE NUMBER	SAMPLE INTERVAL	DEPTH (ft)	LITHOLOGY	WELL CONSTRUCTION	DESCRIPTION OF SUBSURFACE MATERIALS
1445	27.5	48/50 for 6"	7					Sandy SILT (ML): brown, slightly moist, hard, with increased clay, trace of coarse sand
1451	28.2	15/36/50 for 6"	8		35			increased sand content, brown to red brown
1503	52.1	26/46/50 for 5.5"	9		40			decreased sand content, abundant mica, dark brown
								increased moisture content
1525	43	20/26/30	10		45			first attempt - no recovery, added sand catcher
								Boring terminated at 45'
					50			
					55			
					60			
					65			
					70			



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Environmental Services

Project Name:
AFCEE D.O.I/ MAFB-550

Project No.:
9560

LOG OF BORING NO. B-3

BORING LOCATION	17' East of southeast corner of UST excavation	ELEVATION AND DATUM	Measured from Ground Level (GL)	
DRILLING AGENCY/DRILLER	A & R Drilling, Inc. / Barry	DATE STARTED	6/19/96	DATE FINISHED 6/19/96
DRILLING EQUIPMENT	CME 75 / 3-1/4" ID Hollowstem	COMPLETION DEPTH (ft)	45'	DEPTH TO BEDROCK (ft) NA
HAMMER WEIGHT/DROP DISTANCE	140 lbs. / 30"	DIAMETER OF BORING (in.)	6"	DIAMETER OF WELL (in.) NA
TYPE OF WELL CASING	NA	SCREEN PERFORATION	NA	SCREEN INTERVAL (ft) NA
TYPE/SIZE OF FILTER PACK	NA	TYPE/THICKNESS OF SEALS	Backfilled with Cement/Bentonite Grout	
WATER DEPTH (ft)	Not Encountered	LOGGED BY	TF	CHECKED BY VJ

TIME	PID (ppm)	BLOW COUNT (per foot)	SAMPLE NUMBER	SAMPLE INTERVAL	DEPTH (ft)	LITHOLOGY	WELL CONSTRUCTION	DESCRIPTION OF SUBSURFACE MATERIALS
0649	0.9	14/32/50	1					2" concrete
0655	12.7	29/32/38	2		5			Silty SAND (SM): brown, very fine to fine, slightly moist, very dense, trace clay, staining and hydrocarbon odor at tip of sampler, at 3.5' fine to medium sand no odor
0704	63.7	22/38/49	3		10			Sandy SILT (ML): olive gray, fine sand, with mica, slightly moist to moist, hard
0712	79.6	22/27/35	4		15			
0721	116	31/39/50	5		20			Silty SAND (SM): olive gray, fine to medium, moist, very dense, trace clay (approx. 3%)
0729	205	27/50 for 5"	6		25			Sandy SILT (ML): olive gray, slightly moist, hard, with clay, fine sand, slightly plasticity
					30			



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Project Name:
AFCEE D.O.I / MAFB-550

Project No.:
9560

LOG OF BORING NO. B-4

TIME	PID (ppm)	BLOW COUNT (per foot)	SAMPLE NUMBER	SAMPLE INTERVAL	DEPTH (ft)	LITHOLOGY	WELL CONSTRUCTION	DESCRIPTION OF SUBSURFACE MATERIALS
0739	70.4	32/44/50 for 5"	7					CLAY (CL): seam 6" to 8"
								Clayey SAND (SC): brown, fine to medium, moist, very dense, medium plasticity
0755	31.9	35/50 for 6"	8		35			Silty SAND (SM): brown, fine, slightly moist, very dense
0807	84.3	19/31/37	9		40			Clayey SAND (SC): brown, fine, slightly moist, very dense, trace medium sand, medium plasticity
								Sandy SILT (ML): dark brown, moist, hard abundant mica
0816	58.2	19/34/48	10		45			Boring terminated at 45'
					50			
					55			
					60			
					65			
					70			



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Environmental Services

Project Name:
AFCEE D.O./ MAFB- 550

Project No.:
9560

LOG OF BORING NO. B-4

BORING LOCATION	Southeast corner of former UST excavation	ELEVATION AND DATUM	Measured from Ground Level (GL)	
DRILLING AGENCY/DRILLER	A & R Drilling, Inc. / Barry	DATE STARTED	6/17/96	DATE FINISHED 6/17/96
DRILLING EQUIPMENT	CME 75 / 3-1/4" ID Hollowstem	COMPLETION DEPTH (ft)	51'	DEPTH TO BEDROCK (ft) NA
HAMMER WEIGHT/DROP DISTANCE	140 lbs. / 30"	DIAMETER OF BORING (in.)	6"	DIAMETER OF WELL (in.) NA
TYPE OF WELL CASING	NA	SCREEN PERFORATION	NA	SCREEN INTERVAL (ft) NA
TYPE/SIZE OF FILTER PACK	NA	TYPE/THICKNESS OF SEALS	Backfilled with Cement/Bentonite Grout	
WATER DEPTH (ft)	51'	LOGGED BY	TF	CHECKED BY VJ

TIME	PID (ppm)	BLOW COUNT (per foot)	SAMPLE NUMBER	SAMPLE INTERVAL	DEPTH (ft)	LITHOLOGY	WELL CONSTRUCTION	DESCRIPTION OF SUBSURFACE MATERIALS
0836								3.5" to 4" asphalt
0842	1.5	7/6/4	1					Silty Sand (SM): brown, fine, slightly moist, loose
0847	1.7	40/50 for 4"	2		5			very dense
0857	30.2	20/42/36	3		10			stained olive brown, heavy hydrocarbon odor, moist
0909	48.1	16/23/30	4		15			continued odor, trace fine to medium gravel, subangular, dense
0919	270	15/23/50	5		20			Sandy SILT (ML): olive brown, moist, hard, fine sand, with slight hydrocarbon odor 0923 - Drillers repaired cable on the downhole hammer 0938 - Completed repairs
0944	328	16/32/50	6		25			Clayey Sand (SC): brown to olive, moist, fine, very dense, with hydrocarbon odor
					30			background PID = .3 to .5

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Environmental Services

Project Name:
AFCEE D.O.I / MAFB-550

Project No.:
9560

LOG OF BORING NO. B-5

BORING LOCATION	Northeast corner of former UST excavation	ELEVATION AND DATUM	Measured from Ground Level (GL)	
DRILLING AGENCY/DRILLER	A & R Drilling, Inc. / Barry	DATE STARTED	6/17/96	DATE FINISHED 6/17/96
DRILLING EQUIPMENT	CME 75 / 3-1/4" ID Hollowstem	COMPLETION DEPTH (ft)	45'	DEPTH TO BEDROCK (ft) NA
HAMMER WEIGHT/DROP DISTANCE	140 lbs. / 30"	DIAMETER OF BORING (in.)	6"	DIAMETER OF WELL (in.) NA
TYPE OF WELL CASING	NA	SCREEN PERFORATION	NA	SCREEN INTERVAL (ft) NA
TYPE/SIZE OF FILTER PACK	NA	TYPE/THICKNESS OF SEALS	Backfilled with Cement/Bentonite Grout	
WATER DEPTH (ft)	Not Encountered	LOGGED BY	TF	CHECKED BY VJ

TIME	PID (ppm)	BLOW COUNT (per foot)	SAMPLE NUMBER	SAMPLE INTERVAL	DEPTH (ft)	LITHOLOGY	WELL CONSTRUCTION	DESCRIPTION OF SUBSURFACE MATERIALS
								3.5" to 4" asphalt
1252	72	7/12/12	1					Silty SAND (SM) [FILL]: brown, fine, slightly moist, medium dense, with mica
1258	89	9/11/13	2		5			increased silt content, trace fine to medium subrounded gravel
1305	63	5/4/7	3		10			
								Clayey SAND (SC) [FILL]: brown, moist, fine, loose, layer of visqueen at 11', medium plasticity
1311	38	17/30/40	4		15			Silty SAND (SM): olive gray, fine, moist, very dense, with hydrocarbon odor
1321	18	13/19/30	5		20			
1330	14	22/50 for 5"	6		25			continued hydrocarbon odor
					30			



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Environmental Services

Project Name:
AFCEE D.O.I / MAFB-550

Project No.:
9560

LOG OF BORING NO. B-6

TIME	PID (ppm)	BLOW COUNT (per foot)	SAMPLE NUMBER	SAMPLE INTERVAL	DEPTH (ft)	LITHOLOGY	WELL CONSTRUCTION	DESCRIPTION OF SUBSURFACE MATERIALS
0954	208.3	35/50 for 5.5"	7					Clayey SAND (SC): brown to olive, moist, fine, very dense, with hydrocarbon odor
								SAND (SP): olive gray, fine to medium, moist, very dense, with hydrocarbon odor
1006	365	20/33/37	8		35			Silty Sand (SM): brown to olive gray, moist, very dense, fine, trace medium, trace clay, with hydrocarbon odor
1020	404	32/28/40	9		40			continued hydrocarbon odor (heavy)
1034	207	17/30/39	10		45			
1105	206		11		50			Boring terminated at 50' Sample saturated at approx. 51', trace of coarse sand
					55			
					60			
					65			
					70			

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Project Name:
AFCEE D.O./ MAFB- 550

Project No.:
9560

LOG OF BORING NO. B-5

Page 2 of 2

Figure A-5a

TIME	PID (ppm)	BLOW COUNT (per foot)	SAMPLE NUMBER	SAMPLE INTERVAL	DEPTH (ft)	LITHOLOGY	WELL CONSTRUCTION	DESCRIPTION OF SUBSURFACE MATERIALS
1340	63	20/38/50 for 5"	7					Silty SAND (SM): olive gray, fine to medium, moist, very dense, with plagioclase fragment, continued odor
1352	275	12/32/49	8		35			increased silt, increased mica, slight odor
1401	100	23/48/50	9		40			fine to medium, slight odor
1413	98	14/32/40	10		45			Boring terminated at 45'
					50			
					55			
					60			
					65			
					70			



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Project Name:
AFCEE D.O./ MAFB- 550

Project No.:
9560

LOG OF BORING NO. B-6

BORING LOCATION	Northwest corner of former UST excavation	ELEVATION AND DATUM	Measured from Ground Level (GL)	
DRILLING AGENCY/ DRILLER	A & R Drilling, Inc. / Barry	DATE STARTED	6/17/96	DATE FINISHED 6/18/96
DRILLING EQUIPMENT	CME 75 / 3-1/4" ID Hollowstem	COMPLETION DEPTH (ft)	45'	DEPTH TO BEDROCK (ft) NA
HAMMER WEIGHT/ DROP DISTANCE	140 lbs. / 30"	DIAMETER OF BORING (in.)	6"	DIAMETER OF WELL (in.) NA
TYPE OF WELL CASING	NA	SCREEN PERFORATION	NA	SCREEN INTERVAL (ft) NA
TYPE/SIZE OF FILTER PACK	NA	TYPE/THICKNESS OF SEALS	Backfilled with Cement/Bentonite Grout	
WATER DEPTH (ft)	Not Encountered	LOGGED BY	TF	CHECKED BY VJ

TIME	PID (ppm)	BLOW COUNT (per foot)	SAMPLE NUMBER	SAMPLE INTERVAL	DEPTH (ft)	LITHOLOGY	WELL CONSTRUCTION	DESCRIPTION OF SUBSURFACE MATERIALS
1520	5	3/1/3	1					3.5" to 4" asphalt
1525	4	3/3/4	2		5			Silty SAND (SM) [FILL]: brown, fine, slightly moist, very loose to loose, trace fine to medium subrounded gravel, visqueen in loose with coarse sand
1535	521		3		10			
1541	172	10/15/25	4		15			SAND (SP) [FILL]: olive gray, fine to medium, slightly moist, dense, trace coarse sand, with heavy hydrocarbon odor, sampler stuck in augers preventing an accurate blow count
1549	141	9/19/24	5		20			Sandy SILT (ML): olive grey, slightly moist, hard, with mica, slight hydrocarbon odor
1600	74	24/39/50	6		25			Clayey SAND (SC): brown, fine to medium, moist, very dense
					30			1603-cable on down-hole hammer kinked, drillers try to repair 1620-could not repair cable, will continue tomorrow



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Project Name:
AFCEE D.O.I / MAFB-550

Project No.:
9560

LOG OF BORING NO. B-7

Page 1 of 2

Figure A-7

TIME	PID (ppm)	BLOW COUNT (per foot)	SAMPLE NUMBER	SAMPLE INTERVAL	DEPTH (ft)	LITHOLOGY	WELL CONSTRUCTION	DESCRIPTION OF SUBSURFACE MATERIALS Continued boring on 6/18/96 at 0800
0805	29	18/40/50 for 4-1/2"	7					Clayey Sand (SC): brown, fine to medium, moist, very dense, strong hydrocarbon odor
0813	79	18/29/35	8		35			Sandy SILT (ML): olive brown, slightly moist, hard, fine sand, with mica, with hydrocarbon odor
0823	20	17/20/40	9		40			Silty SAND (SM): brown, fine, slightly moist, dense to very dense, trace clay, trace coarse sand, medium plasticity strong hydrocarbon odor
0845	44	17/27/32	10		45			Boring terminated at 45'
					50			
					55			
					60			
					65			
					70			



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Project Name:
AFCEE D.O.I./ MAFB-550

Project No.:
9560

LOG OF BORING NO. B-7

BORING LOCATION		ELEVATION AND DATUM	Measured from Ground Level (GL)			
DRILLING AGENCY/ DRILLER		A & R Drilling, Inc. / Barry	DATE STARTED	6/19/96	DATE FINISHED	6/19/96
DRILLING EQUIPMENT		CME 75 / 3-1/4" ID Hollowstem	COMPLETION DEPTH (ft)	45'	DEPTH TO BEDROCK (ft)	NA
HAMMER WEIGHT/ DROP DISTANCE		140 lbs. / 30"	DIAMETER OF BORING (in.)	6"	DIAMETER OF WELL (in.)	NA
TYPE OF WELL CASING		NA	SCREEN PERFORATION	NA	SCREEN INTERVAL (ft)	NA
TYPE/SIZE OF FILTER PACK		NA	TYPE/THICKNESS OF SEALS	Backfilled with Cement/Bentonite Grout		
WATER DEPTH (ft)		Not Encountered	LOGGED BY	TF	CHECKED BY	VJ

TIME	PID (ppm)	BLOW COUNT (per foot)	SAMPLE NUMBER	SAMPLE INTERVAL	DEPTH (ft)	LITHOLOGY	WELL CONSTRUCTION	DESCRIPTION OF SUBSURFACE MATERIALS
								4" to 5" asphalt
1502	346	28/32/40	1		5			SILT (ML): with trace of clay, hard, slightly moist, brown
1513	290	19/38/42	2		10			decreased clay, olive gray
1526	392	14/20/35	3		15			
1537	391	14/24/35	4		20			Clayey SAND (SC): moist, gray, dense
1545	359	19/28/39	5		25			Sandy Clay (CL): moist, gray, hard
					30			



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Project Name:
AFCEE D.O.I / MAFB-550

Project No.:
9560

LOG OF BORING NO. B-8

BOREHOLE LOGS

TIME	PID (ppm)	BLOW COUNT (per foot)	SAMPLE NUMBER	SAMPLE INTERVAL	DEPTH (ft)	LITHOLOGY	WELL CONSTRUCTION	DESCRIPTION OF SUBSURFACE MATERIALS
1555	67	21/33/59	6					Sandy SILT (ML): with trace of clay, reddish brown, hard, slightly moist, trace olive gray clay
1611	49	23/43/48	7		35			Silty SAND (SM): brown, fine to medium, very dense, slightly moist
1629	15.7	42/50 for 5"	8		40			slight plasticity
1653	33.8	13/19/29	9		45			increased moisture, fine
					50			
					55			
					60			
					65			
					70			
								Boring terminated at 45'



CKY incorporated
Environmental Services

Project Name:
AFCEE D.O.I/ MAFB-550

Project No.:
9570

LOG OF BORING NO. B-8

BORING LOCATION	South of Building 550	ELEVATION AND DATUM	1537.62' MSL @ ground level	
DRILLING AGENCY/ DRILLER	A & R Drilling, Inc. / Mario	DATE STARTED	11/26/96	DATE FINISHED 11/27/96
RILLING EQUIPMENT	CME 85 / Hollow Stem Augers	COMPLETION DEPTH (ft)	60'	DEPTH TO BEDROCK (ft) NA
HAMMER WEIGHT/ DROP DISTANCE	140 lbs. / 30"	DIAMETER OF BORING (in.)	10	DIAMETER OF WELL (in.) 4
TYPE OF WELL CASING	Schedule 40 PVC	SCREEN PERFORATION	0.01	SCREEN INTERVAL (ft) 45 to 60
TYPE/SIZE OF FILTER PACK	Lonestar # 2/16	TYPE/THICKNESS OF SEALS	3' from 40' to 43'	
WATER DEPTH (ft)	First Encounted at 52'	LOGGED BY	TF	CHECKED BY VJ

TIME	PID (ppm)	BLOW COUNT (per foot)	SAMPLE NUMBER	SAMPLE INTERVAL	DEPTH (ft)	LITHOLOGY	WELL CONSTRUCTION	DESCRIPTION OF SUBSURFACE MATERIALS
1500								Moved boring approx. 2' to the Southeast due to utility lines.
								3" Asphalt
								Concrete cap with traffic rated well box
								Sandy SILT (ML): brown, slightly moist, hard, trace mica, with fine sand.
1515	6.9	9/18/50	1		5			@ 6.5' color change to green-gray
								4" PVC Schedule 40 blank casing
1526	330	9/18/27	2		10			
								with strong hydrocarbon odor
1537	420	7/16/30	3		15			
								Clayey SAND (SC): green-gray, medium to coarse, slightly moist, very dense, strong hydrocarbon odor.
1550	161	19/40/50 for 5"	4		20			Portland cement grout with 3% benonite powder
								increased clay content, continued odor
1600	314	9/17/42	5		25			
								Clayey SILT (ML): brown, slightly moist, hard, slight plasticity, slight hydrocarbon odor
					30			



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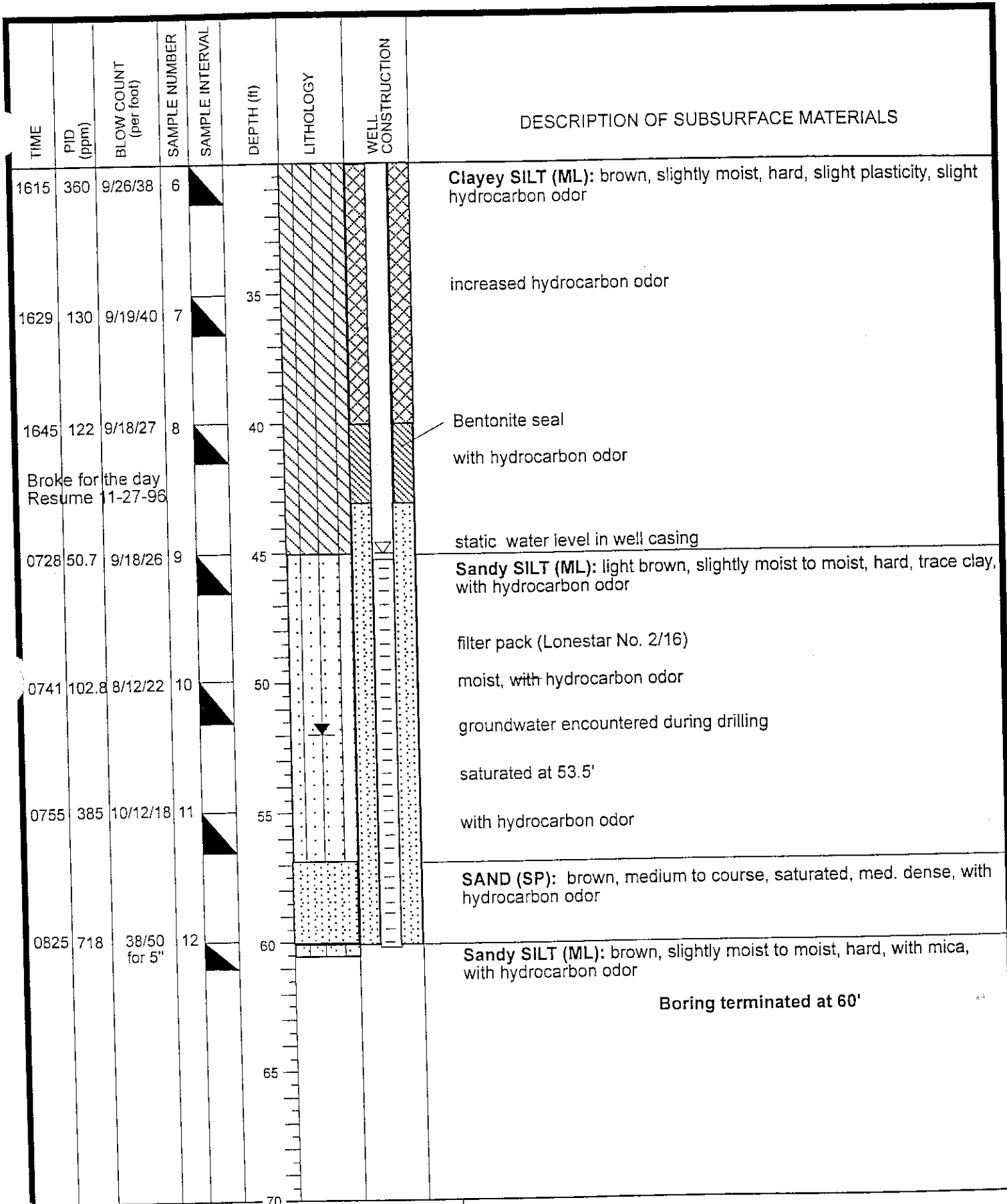
Project Name:
AFCEE MAFB-550

Project No.:
9560

LOG OF BORING NO.
MAFB-550-MW1

Page 1 of 2

Figure A-9



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Environmental Services

Project Name:
AFCEE MAFB - 550

Project No.:
9560

LOG OF BORING NO.
MAFB-550-MW1

BORING LOCATION	East of Building 549	ELEVATION AND DATUM	1537.17' MSL @ ground level	
DRILLING AGENCY/ DRILLER	A & R Drilling, Inc. / Mario	DATE STARTED	11/26/96	DATE FINISHED 11/26/95
DRILLING EQUIPMENT	CME 85	COMPLETION DEPTH (ft)	55'	DEPTH TO BEDROCK (ft) NA
HAMMER WEIGHT/ DROP DISTANCE	140 lbs. / 30"	DIAMETER OF BORING (in.)	10"	DIAMETER OF WELL (in.) 4"
TYPE OF WELL CASING	Schedule 40 PVC	SCREEN PERFORATION	0.01	SCREEN INTERVAL (ft) 40' to 55'
TYPE/SIZE OF FILTER PACK	Lonestar #2/16	TYPE/THICKNESS OF SEALS	3' form 35' to 38'	
WATER DEPTH (ft)	First encountered at 47'	LOGGED BY	TF	CHECKED BY VJ

TIME	PID (ppm)	BLOW COUNT (per foot)	SAMPLE NUMBER	SAMPLE INTERVAL	DEPTH (ft)	LITHOLOGY	WELL CONSTRUCTION	DESCRIPTION OF SUBSURFACE MATERIALS
0835								3" asphalt, 3" to 4" base
								concrete cap with traffic rated well box
								Silty CLAY (CL): brown, slightly moist, hard, trace mica
0843	669	8/16/38	1		5			
								4" PVC schedule 40 blank casing
0854	277	9/16/30	2		10			trace gravel to 3/4", subrounded
								increased silt content
0905	669	10/18/20	3		15			
0924	699	12/20/30	4		20			Portland cement grout with 3% bentonite powder
0934	699	9/12/22	5		25			
					30			



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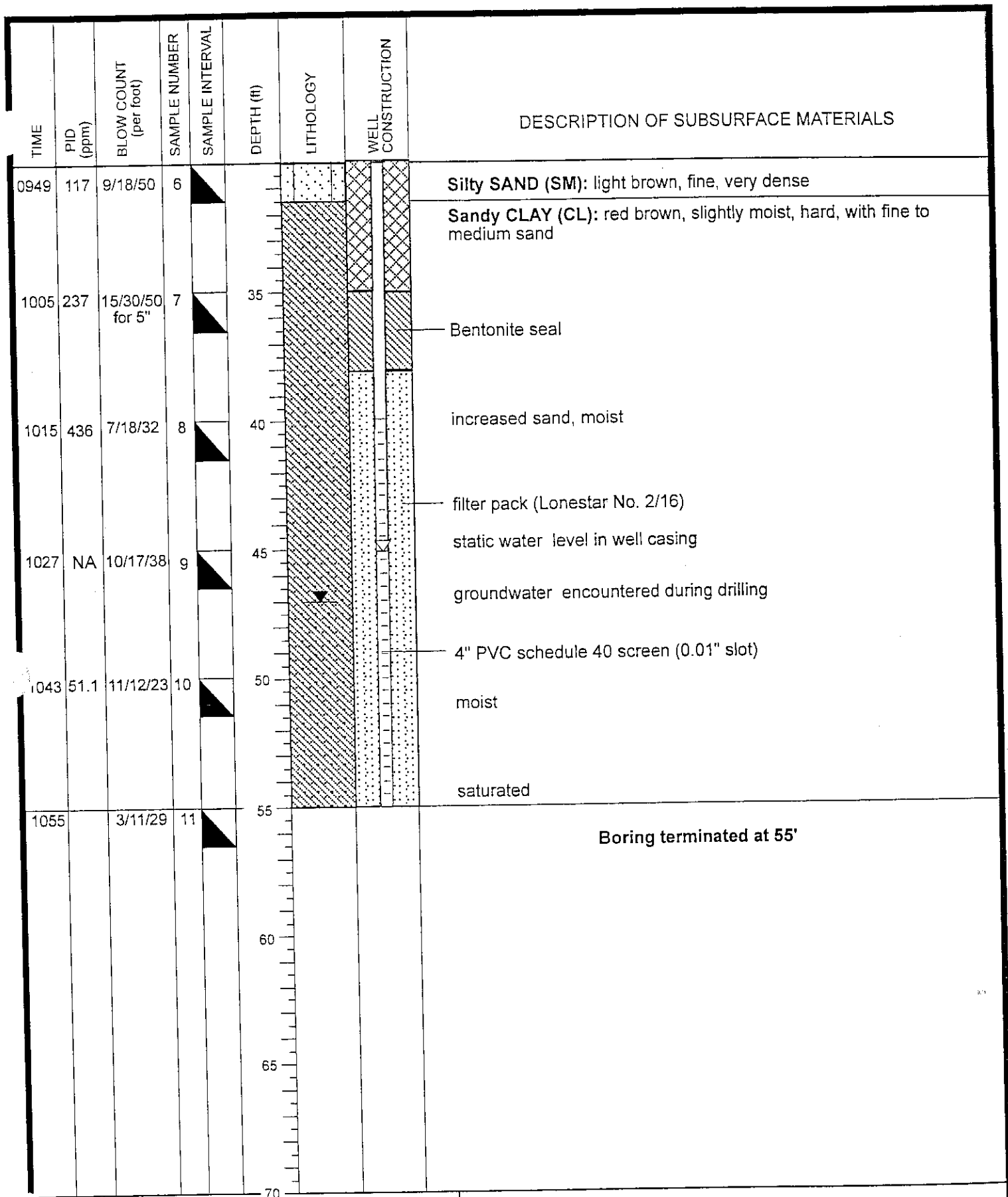
Project Name:
AFCEE D.O.I / MAFB-550

Project No.:
9560

LOG OF BORING NO.
MAFB-550-MW2

Page 1 of 2

Figure A-10



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Project Name:
AFCEE D.O.I/ MAFB-550

Project No.:
9560

**LOG OF BORING NO.
MAFB-550-MW2**

Page 2 of 2

Figuer A-10a

BORING LOCATION	West of Building 549	ELEVATION AND DATUM	1537.81' MSL @ ground level	
DRILLING AGENCY/ DRILLER	A & R Drilling, Inc. / Mario	DATE STARTED	11/25/96	DATE FINISHED 11/25/95
DRILLING EQUIPMENT	CME 85	COMPLETION DEPTH (ft)	63"	DEPTH TO BEDROCK (ft) NA
HAMMER WEIGHT/ DROP DISTANCE	140 lbs. / 30"	DIAMETER OF BORING (in.)	10"	DIAMETER OF WELL (in.) 4"
TYPE OF WELL CASING	Schedule 40 PVC	SCREEN PERFORATION	0.01	SCREEN INTERVAL (ft) 53' to 63'
TYPE/SIZE OF FILTER PACK	Lonestar #2/16	TYPE/THICKNESS OF SEALS	3' from 48' to 51"	
WATER DEPTH (ft)	First encountered at 59'	LOGGED BY	TF	CHECKED BY VJ

TIME	PID (ppm)	BLOW COUNT (per foot)	SAMPLE NUMBER	SAMPLE INTERVAL	DEPTH (ft)	LITHOLOGY	WELL CONSTRUCTION	DESCRIPTION OF SUBSURFACE MATERIALS
0855								3" asphalt, 3" to 4" base
0913	131	29/40/42	1					SAND (SP): light brown, medium to coarse, slightly moist, mica
								concrete cap with traffic rated well box
0930	12.9	5/8/26	2		5			SILT (ML): red brown, slightly moist, hard, trace clay, slight plasticity
								trace coarse gravel, light brown
								4" PVC schedule 40 blank casing
0938	550	7/12/24	3		10			Sandy CLAY (CL): light brown, slightly moist, hard
0959	669	12/14/20	4		15			
								Portland cement grout with 3% bentonite powder
1007	669	13/18/30	5		20			
								with 1/8" - 1/4" micaceous coarse sand
1016	669	11/20/45	6		25			
								Silty SAND (SM): light brown, fine, slightly moist, very dense
					30			



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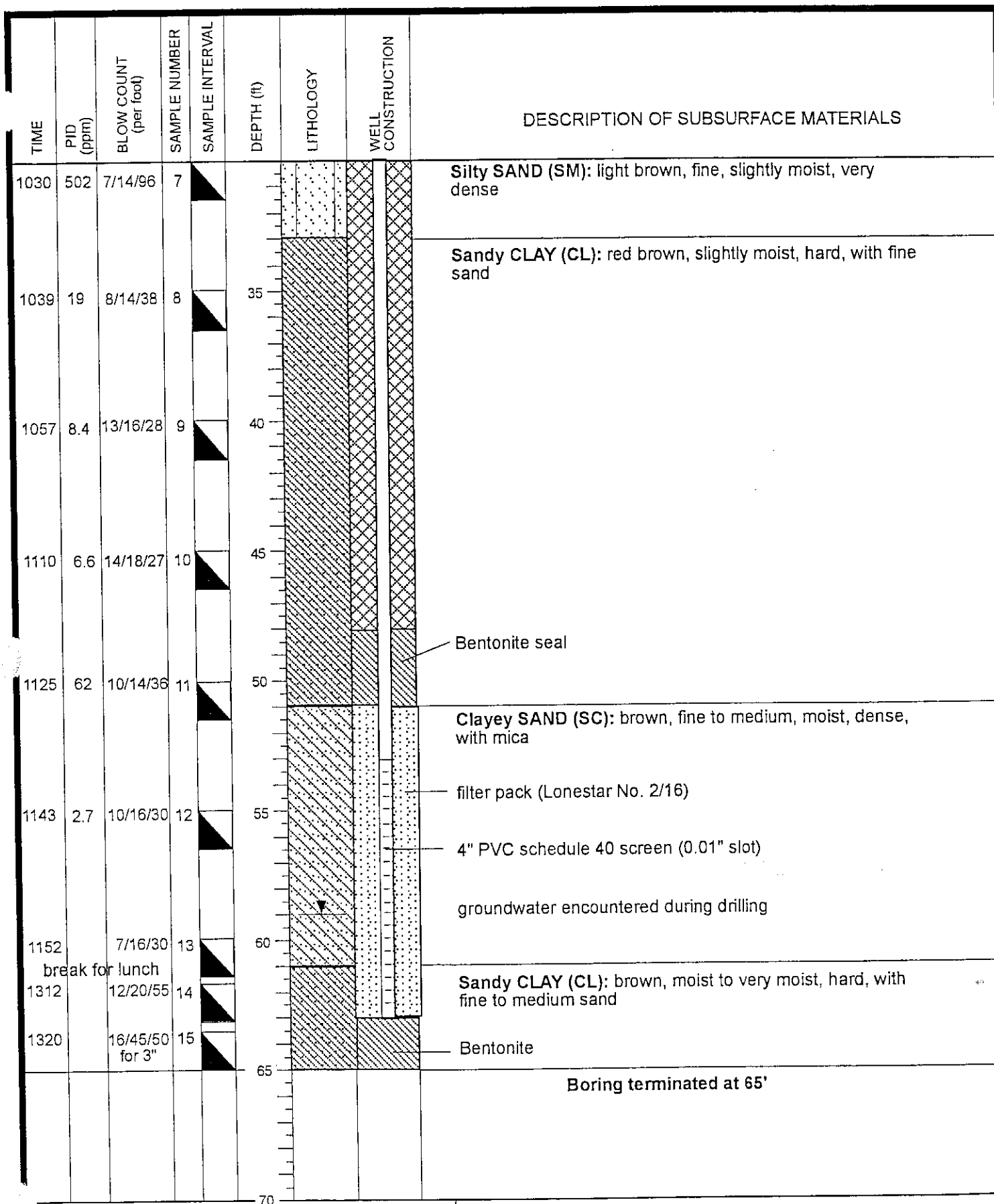
Project Name:
AFCEE D.O.I / MAFB-550

Project No.:
9560

LOG OF BORING NO.
MAFB-550-MW3

Page 1 of 2

Figure A-11



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Project Name:
AFCEE D.O.I/ MAFB-550

Project No.:
9650

LOG OF BORING NO. MAFB-550-MW3



BORING LOG

Logged By: R. Doss

Sheet 1
of 6

Dist. from Surf.	Water Sample Interval	Water Sample No.	USCS	Log of Material	Remarks
0			SM (Fill)	Asphalt: 4" thick	Hand augered to 5'.
				@ 0-5': Silty sand; fine grained, some gravel, yellowish brown (10YR 5/6), mottled; damp.	Headspace (HS) (2'), 2.4 ppm
5			NR	@ 5' - 12': No recovery; lost sample.	Diameter of continuous-core sampler is 2 1/2".
					Diameter of outer casing (O.C.) 8 5/8"
10					
			SM (Fill)	@ 12' - 13': Silty sand; same as above.	
			SM	@ 13' - 17': Silty Sand; mostly fine; dark greyish brown (10YR 4/2); native soil.	HS (13'): 420 ppm Strong hydrocarbon odor
15				@ 15' - 17': Color change to olive brown (2.5YR 4/4).	HS (15'): 1000+ ppm
			NR	@ 17' - 19': No Recovery.	
			ML	@ 19' - 20': Sandy Silt; fine; dark yellowish brown (10YR 4/6).	HS (19'): 1000+ ppm (FID) 2500+ ppm (PID)
20					



BORING LOG

Logged By: R. Doss

Sheet 2
of 6

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BORING LOG

Logged By: R. Doss

Sheet 3
of 6

G:\Data\Borlogs\MW4.CDR 12/10/98



TETRA TECH INC.

BORING LOG

Date: 11/9/98, 11/10/98

Location: Source Area (Former Tank Location)

Logged By: R. Doss

Hole No.: MW-4

Project No.: 10052-01

Project: Site 12A (B-550)
Additional Site CharacterizationSheet 4
of 6

Dist. from Surf.	Water Sample Interval	Water Sample No.	USCS	Log of Material	Remarks
60			SM/ML	@ 60' - 65': Silty Sand and Sandy Silt; fine (~40% silt); dark yellowish brown (10YR 4/4); moist; loose to dense.	HS (60'): 2500+ ppm (PID) (62'): 2500+ ppm (PID) (64'): 1700+ ppm (PID) (65'): 2500+ ppm (PID) @ 60-65': RCWL= 0.10 gal/min. to 0.20 gal/min. (after bailing)
		MW465W	SM	@ 64': Silt content decreases to ~ 30%.	Switched to 6" diameter continuous core sampler.
65			SM/ML	@ 65' - 70': Silty Sand and Sandy Silt; mostly fine (~ 40 - 50% silt), dark yellowish brown (10YR 4/4); micaceous; moist.	HS (66'): 2500 + ppm (PID) (67'): 2500 + ppm (PID) (68'): 1300 ppm (PID) (69'): 358 ppm (PID) (70'): 347 ppm (PID)
70			SM	@ 70' - 72.5': Silty Sand; mostly fine (~30% silt); dark yellowish brown (10YR 4/6); moderately dense; micaceous.	HS (70.5'): 874 ppm (PID) (71.5'): 84 ppm (PID) (72.5'): 59 ppm (PID) (73.5'): 37 ppm (PID) (74.5'): 33 ppm (PID)
		MW4-73W	SW	@ 72.5' - 74.5': Sand; fine to medium with ~ 20% silt; dark yellowish brown (10YR 4/6), loose; very moist.	
75			SM	@ 74.5' - 75': Silty Sand; mostly fine (~ 30-40% silt); damp.	
			NR	@ 75' - 78': No recovery.	
			SW	@ 78' - 79': Sand; fine to coarse with silt (~ 5 - 10%); yellowish brown (10YR 5/6), wet; loose.	HS (78): 100 ppm (FID) (80): 30 ppm (PID)
80			SM/ML	@ 79' - 80': Silty Sand and Sandy Silt (~ 40 - 50% silt); damp.	



TETRA TECH INC.

BORING LOG

Date: 11/10/98

Location: Source Area (Former Tank Location)

Logged By: R. Doss

Hole No.: MW-4

Project No.: 10052-01

Project: Site 12A (B-550)
Additional Site CharacterizationSheet 5
of 6

Dist. from Surf.	Water Sample Interval	Water Sample No.	USCS	Log of Material	Remarks
80			NR	@ 80' - 82': No recovery.	
					HS (82.5'): 7 ppm (FID)
				@ 82' - 83': Silty Sand; fine to coarse (mostly fine); yellowish brown (10YR 5/4), medium dense; damp.	(84'): 7 ppm (FID)
			SM	@ 83' - 85': Same as above except fewer coarse grains and very dense.	(85'): 4 ppm (FID)
85				@ 85' - 87.5': Silty Sand same as 82' - 83'; becomes slightly finer with depth.	HS (86'): 6.5 ppm (FID)
					(87'): 5 ppm (FID)
					@ 85-87': RCWL=0. gal/min.
		MW4-87W			
				@ 87.5' - 93': Silty Sand with ~ 5% clay, fine to medium (mostly fine); dark yellowish brown (10YR 4/4); a few gravel-sized rock fragments; dark matrix staining from biotite weathering; moist; very dense; becomes slightly coarser with depth.	HS (88'): 413 ppm (PID)
					(89'): 394 ppm (PID)
					(90'): 414 ppm (PID)
					(91'): 264 ppm (PID)
90					(92'): 336 ppm (PID)
					(93'): 350 ppm (PID)
				@ 93' - 96': Silty Sand with clay; same as above.	HS (93.5'): 35 ppm (PID)
					(94.5'): 63 ppm (PID)
					(95.5'): 36 ppm (PID)
95					
		MW4-96W			
			NR	@ 96' - 97': No recovery.	
					@ 95-96': RCWL= 0.025 gal/min.
			SW	@ 97' - 100': Sand; fine to coarse with ~ 10% silt; fine gravel (~5%); a few silt/clay nodules; loose; wet.	HS (97.5'): 56 ppm (PID)
					(99'): 57 ppm (PID)
					(100'): 39 ppm (PID)
				Becomes finer and denser with depth.	
100					



BORING LOG

Logged By: R. Doss

Sheet 6
of 6

Dist. from Surf.	Water Sample Interval	Water Sample No.	USCS	Log of Material	Remarks
100			NR	@ 100' - 102': No recovery.	
			SM	@ 102' - 107': Silty Sand; fine to medium with minor coarse grains; dark yellowish brown (10YR 4/6); micaceous: dense: becomes very dense at 104'.	HS (103'): 5 ppm (PID) (104'): 8 ppm (PID) (105'): 10 ppm (PID) (106'): 12 ppm (PID) (107'): 10 ppm (PID)
105					
				@ 107' - 110' : Same as above with slightly higher silt content; very dense.	HS (108'): 20 ppm (PID) (109'): 20 ppm (PID) (110'): 20 ppm (PID)
					@ 015-110': RCWL=0.6 gal/min.
110					
				Total Depth: 110'	
115					
			SM		
120					



TETRA TECH INC.

BORING LOG

Date: 11/16/98

Location: Downgradient

Logged By: R. Doss

Hole No.: MW-5

Project No.: 10052-01

Project: Site 12A (B-550)
Additional Site CharacterizationSheet 1
of 6

Dist. from Surf.	Water Sample Interval	Water Sample No.	USCS	Log of Material	Remarks
0			SM/ML	Asphalt: 4" thick.	Hand augered to 5'.
				@ 0-5': Silty Sand and Sandy Silt; fine (~ 40-50% silt); yellowish brown (10YR 5/6); loose; slightly moist.	Diameter of outer casing (O.C.) 8 5/8".
					Diameter of continuous core sampler: 6".
5			SM	@ 5' - 10': Sand; silty; mostly fine (~ 30% silt); more dense than above; slightly moist.	HS (5'): 8 ppm (PID)
					(6'): 12 ppm (PID)
					(7'): 7 ppm (PID)
					(8'): 12 ppm (PID)
					(9'): 17 ppm (PID)
					(10'): 32 ppm (PID)
10				@ 10' - 15': Same as above with black matrix staining from weathering biotite; loose; moist.	No hydrocarbon odor.
					HS (11'): 125 ppm (PID)
					(12'): 305 ppm (PID)
					(13'): 438 ppm (PID)
					(14'): 415 ppm (PID)
					(15'): 161 ppm (PID)
				Silt content increases to ~ 40%.	
15				@ 15' - 20': Same as above (10'-15').	HS (16'): 185 ppm (PID)
					(17'): 23 ppm (PID)
					(18'): 130 ppm (PID)
					(19'): 300 ppm (PID)
					(20'): 218 ppm (PID)
20					



TETRA TECH INC.

BORING LOG

Date: 11/16/98

Location: Downgradient

Logged By: R. Doss

Hole No.: MW-5

Project No.: 10052-01

Project: Site 12A (B-550)
Additional Site CharacterizationSheet 2
of 6

Dist. from Surf.	Water Sample Interval	Water Sample No.	USCS	Log of Material	Remarks
20			SM	@ 20' - 23.5': Silty Sand; same as above except lower silt content (~ 20% silt).	HS (21'): 226 ppm (PID) (22'): 431 ppm (PID) (23'): 272 ppm (PID) (24'): 128 ppm (PID) (25'): 197 ppm (PID)
			SW	@ 22.5': Sand fine to medium with silt (<10% silt), loose; moist.	
25			SM	@ 24': Silty Sand; same as at 20'. @ 25' - 30': Silty Sand; fine to coarse with clay (~ 5% clay); dense; moist; feldspar grains weathering to clay.	HS (26'): 124 ppm (PID) (27'): 80 ppm (PID) (28'): 117 ppm (PID) (29'): 130 ppm (PID) (30'): 250 ppm (PID)
30			SM/ML	@ 30' - 35': Silty Sand and Sandy Silt; fine; granitic rock fragments to fine gravel size; occasional granitic rock several inches in diameter, well-rounded to subrounded; yellowish brown (10YR 5/6); dense; moist. Biotite and feldspar grains are severely weathered.	HS (31'): 971 ppm (PID) (32'): 1053 ppm (PID) (33'): 741 ppm (PID) (34'): 655 ppm (PID) (35'): 1183 ppm (PID)
35				@ 35' - 40': Silty Sand and Sandy Silt; same as above.	HS (36'): 700 ppm (PID) (37'): 700 ppm (PID) (38'): 610 ppm (PID) (39'): 275 ppm (PID) (40'): 355 ppm (PID)
40			SM	@ 39.5': Increasing sand content.	



TETRA TECH INC.

BORING LOG

Date: 11/16/98

Location: Downgradient

Logged By: R. Doss

Hole No.: MW-5

Project No.: 10052-01

Project: Site 12A (B-550)
Additional Site CharacterizationSheet 3
of 6

Dist. from Surf.	Water Sample Interval	Water Sample No.	USCS	Log of Material	Remarks
40			SM/ML	@ 40' - 45': Silty Sand and Sandy Silt; fine to medium; minor coarse (~ 20-30% silt); moist.	HS (41'): 475 ppm (PID) (42'): 425 ppm (PID) (43'): 425 ppm (PID) (44'): 225 ppm (PID) (45'): 310 ppm (PID)
				Silt content increases with depth.	@ 41' - 50': RCWL = 0.02 gal/min.
45			NR	@ 45' - 46': No recovery.	
	MW5-46W		SM/SW	@ 46' - 49': Silty Sand; fine to coarse. Silt content decreases with depth.	HS (47'): 55 ppm (PID) (48'): 74 ppm (PID) (49'): 77 ppm (PID) (50'): 115 ppm (PID)
50			SM	@ 49.5': Silty Sand; same as above except mostly fine.	HS (51'): 12 ppm (PID)
			SM/ML	@ 50' - 53': Silty Sand and Sandy Silt; fine (~ 40-50% silt); dark yellowish brown (10YR 4/4), moist. Silt content decreases with depth.	(52'): 26 ppm (PID) (53'): 88 ppm (PID)
				@ 53' - 55': Silty Sand; fine to medium (~ 20% silt); olive brown (2.5YR 4/4); loose; moist.	Noticeable color change; slight hydrocarbon odor. HS (54'): 219 ppm (PID) (55'): 169 ppm (PID)
55			NR	@ 55' - 57': No recovery (sample lost during clean run).	@ 55' - 65': RCWL = 0.02 gal/min.
	MW4-57W		SM	@ 57' - 62': Silty Sand; yellowish brown (10YR 4/4); slightly moist; Silt content decreases with depth.	Noticeable color change. HS (57'): 18 ppm (PID) (58'): 43 ppm (PID) (59'): 20 ppm (PID) (60'): 18 ppm (PID)
60					



BORING LOG

Logged By: R. Doss

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of 6

Dist. from Surf.	Water Sample Interval	Water Sample No.	USCS	Log of Material	Remarks
60			SM/ML	@ 60' - 65': Silty Sand and Sandy Silt; fine (~40% silt), dark yellowish brown (10YR 4/4); moist; loose to dense.	HS (61'): 34 ppm (PID) (62'): 41 ppm (PID) (63'): 48 ppm (PID) (64'): 78 ppm (PID) (65'): 63 ppm (PID)
				@ 62' - 65': Silty Sand; fine (~30% silt); minor coarse; yellowish brown (10YR 4/4); moist; medium dense.	PID malfunctions; FID used from here on.
				Silt content increases with depth (~40-50% silt).	
65			SM	@ 65' - 70': Silty Sand; fine; minor medium/coarse; clay (~5-10%); yellowish brown (10YR 4/4); biotite grains are extremely weathered; dense; moist.	HS (66'): 190 ppm (67'): 120 ppm (68'): 200 ppm (69'): 50 ppm (70'): 20 ppm
70				@ 70' - 75': Silty Sand; same as above; Silt content decreases with depth.	HS (71'): 30 ppm (72'): 40 ppm (73'): 90 ppm (74'): 58 ppm (75'): 80 ppm @ 70 - 75'; RCWL = 0.7 gal/min.
		MW5-74W			
75			NR	@ 75' - 78': No recovery.	
			SM	@ 78' - 82': Silty Sand; fine; minor medium/coarse (~5% clay, ~35% silt); yellowish brown (10YR 4/4); dense; moist.	HS (79'): 20 ppm (80'): 7 ppm
80					



BORING LOG

Logged By: R. Doss

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of 6

Dist. from Surf.	Water Sample Interval	Water Sample No.	USCS	Log of Material	Remarks
80			SM	@ 80': Silt content decreases with depth (~ 20% silt); loose to moderately dense; moist.	HS (81'): 6 ppm (82'): 28 ppm
					HS (83'): 9 ppm
				@ 82' - 85': Silty Sand; fine; minor medium; yellowish brown (10YR 4/4); very dense; very moist; mafic minerals show high degree of weathering.	(84'): 6 ppm (85'): 5 ppm
85				@ 85' - 90': Silty Sand; fine; minor medium/coarse (~ 20-30% silt); dense; moist.	
					HS (86'): 30 ppm
					(87'): 28 ppm
					(88'): 200 ppm
	MW5-84W			@ 87.5': Silt content decreases with depth; loose; very moist.	(89'): 8 ppm (90'): 5 ppm
					@ 87' - 94': RCWL = 0.6 gal/min.
90			SW	@ 89.5': Sand; fine to coarse with silt; strong brown	
			NR	(7.5YR 5/8).	
				@ 90' - 91': No recovery (core lost during clean-out).	
			SW	@ 91' - 94': Sand; same as above.	
95			NR	@ 94' - 97': No recovery.	
			SW	@ 97' - 100': Sand; fine to coarse with silt ; same as above.	HS (97'): 7 ppm
					(98'): 20 ppm
					(99'): 7 ppm
				Becomes coarser and less silty with depth.	(100'): 6 ppm
100					

Date: 11/17/98

Location: Downgradient

Logged By: R. Doss

Hole No.: MW-4

Project No.: 10052-01

Project: Site 12A (B-550)
Additional Site Characterization

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of 6

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TETRA TECH INC.

BORING LOG

Date: 11/19/98

Location: Upgradient

Logged By: S. Reinholtz

Hole No.: MW-6

Project No.: 10052-01

Project:

Sheet 1
of 4

Dist. from Surf.	Water Sample Interval	Water Sample No.	USCS	Log of Material	Remarks
0			SM	Silty Sand; dark reddish brown (5YR 3/4), 75% fine to medium grained, SA-SR; quartz/feldspar; 25% low plasticity silt; dense; moist.	4" AC Hand Auger
					1320
5				@ 5': Silty Sand.	5' - 6': 1 ppm BGD= 4ppm
					6' - 7': 0 ppm
				@ 6' - 8': Silty Sand; same as above except increase in sand to 80%; medium dense.	7' - 8': 0 ppm
					8' - 9': 0 ppm
					9' - 10': 0 ppm
					1325
					10' - 11': 4 ppm BGD= 4ppm
10				@ 10': Silty Sand; light olive brown 92.5YR 5/6), 60% very fine to fine sand; 40% low plasticity silt; medium dense; moist	11' - 12': 1 ppm
					12' - 13': 0 ppm
					13' - 14': 1 ppm
					14' - 15': 4 ppm
				@ 13' - 15': Same as above except increase in sand to 80% fine to coarse; loose; moist.	1328 Advance 8" casing to 10' bgs
15			NR		
					1340 HS
					16.5' - 17': 900 ppm 20 ppm
			SM	@ 17': Silty Sand; same as above except less coarse; at 17' - 18' increase in fines and silt content @ 40%.	17' - 18': 1,000 ppm 19 ppm
				@ 18' - 20': 80% fine to medium grained sand.	18' - 19': 1,000 ppm 10 ppm
					19' - 26': 800 ppm 15 ppm
20					



TETRA TECH INC.

BORING LOG

Date: 11/19/98

Location: Upgradient

Logged By: S. Reinholtz

Hole No.: MW-6

Project No.: 10052-01

Project:

Sheet 2
of 4

Dist. from Surf.	Water Sample Interval	Water Sample No.	USCS	Log of Material	Remarks
20			SW	@ 20' : Sand; olive brown (2.5YR 4/3); fine to coarse grained; SA-SE quartz/feldspar; trace mica; loose; moist.	1348 Advance 8" Casing to 15'; Core 20' - 25'; HS 1405
				@ 21' - 22': Increase in coarse grains.	20' - 21': 200 ppm 2 ppm
				@ 22' - 23': Color change to dark yellowish brown (10YR 4/6); dense; dry.	21' - 22': 300 ppm 7 ppm 22' - 23': 100 ppm 6 ppm
					23' - 24': 250 ppm 10 ppm
			ML	@ 23' - 24': Sandy Silt; olive brown (2.5YR 5/3); 90% low to medium plasticity silt; 10% fine grained sand; firm; moist.	24' - 25': 200 ppm 10 ppm Advance Casing to 20'@ 1355
25			SM	@ 24': Silty Sand; olive (5YR 5/3); 65% fine to medium, S-SR; 85% low plasticity silt; medium dense; moist.	1418 core 25' - 30' HS 1441 25' - 26': 1,000+ ppm 8 ppm
				@ 25': Same as @ 20' except fine to medium.	26' - 27': 1,000+ ppm 5 ppm 27' - 28': 1,000+ ppm 38 ppm
			ML	@ 26' - 30': Sandy Silt; yellowish red (5YR 5/6); 85% low plasticity silt; 10% very fine to fine sand; ≤ 5% low plasticity clay; soft; moist.	28' - 29': 1,000+ ppm 10 ppm 29' - 30': 1,000+ ppm 10 ppm
					Core 30' - 35' (1430)
30					Advance Casing to 30' (1432)
				@ 30' - 33': Same as above except dry.	30 - 31': 1,000+ ppm 40 ppm
					31' - 32': 1,000+ ppm 18 ppm
					32' - 33': 1,000+ ppm 40 ppm
					33' - 34': 1,000+ ppm 30 ppm
					34' - 35': 1,000+ ppm 10 ppm
					HS 1449
			SM	@ 33' - 35': Gravelly Silty Sand; yellowish red (5YR 5/6); 80% fine to coarse grained; SA-SR; quartz/feldspar; 10% low plasticity silt; 10% SA rock fragments.	
35			ML	@ 35' - 38': Sandy Silt; yellowish brown (10YR 5/8); same as @ 26' - 30'.	Core 35' - 40' (1456) 35' - 36': 1,000+ ppm 60 ppm
					36' - 37': 1,000+ ppm 34 ppm
					37' - 38': 1,000+ ppm 50 ppm
					38' - 39': 1,000+ ppm 12 ppm
					39' - 40': 1,000+ ppm 10 ppm
			SM	@ 38': Silty Sand; same color as above; 75 - 85% fine to medium; SA-SR; quartz/feldspar; 75% low plasticity silt; medium dense; moist.	HS 1512 1500 and 8" to 35' bgs
40				@ 40': finer dark grains.	Slight Odor @ 35' - 40'



TETRA TECH INC.

BORING LOG

Date: 11/19/98

Location: Upgradient

Logged By: S. Reinholtz

Hole No.: MW-6

Project No.: 10052-01

Project:

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of 4

Dist. from Surf.	Water Sample Interval	Water Sample No.	USCS	Log of Material	Remarks
40			SM	@ 40' - 44': Silty Sand; yellowish brown (10YR 5/6); 90 - 95% fine to medium sand; SA-SR; quartz/feldspar; \approx 5% low plasticity silt; loose; wet.	Core 40 - 45 (1525) 40' - 41': 1,000 ppm 20 ppm 41' - 42': 200 ppm 100 ppm 42' - 43': 40 ppm 70 ppm 43' - 44': 500 ppm 30 ppm 44' - 45': 400 ppm 30 ppm HS @ 1536
45			ML	@ 44' - 45': Fines increase to 15 - 20% low plasticity silt. @ 45': Sandy Silt; color as above; 80 - 85% low plasticity silt; \approx 15% very fine to fine sand; soft; moist. @ 46' - 47': Increase in sand to 20%. @ 47' - 48': Decrease in sand to \leq 10%.	Core 45 - 50 (1525) 45' - 46': 5 ppm 20 ppm 46' - 47': 30 ppm 6 ppm 47' - 48': 6 ppm 6 ppm 48' - 49': 4 ppm 5 ppm 49' - 50': 26 ppm 5 ppm HS @ 1622 SWL 43.5'
50			SM	@ 48' - 50': Silty Sand; same as @ 40' - 44' except fine to coarse grained with \approx 5% silt; loose; wet. @ 50' - 55': Same as above (48' - 50').	1621 Advance casing to 45' bgs. Clean run 50' - 51': 30 ppm 51' - 52': 120 ppm 52' - 53': 70 ppm 53' - 54': 500 ppm 54' - 55': 900 ppm 45 ppm (9:00) 54' - 55' core: 10 ppm 7:40 Stand by begins 8:00 Stand by ends
55			NR	@ 55' - 58': No Recovery	
60			SM	@ 58' - 60': Silty Sand; fine to coarse (\approx 20% silt); fine gravel and a few rocks (to 2" diameter); moist to wet; loose; becomes more sandy with depth (\approx 10% silt).	60' 88 ppm 59' 400 ppm O.C. \geq 60 (8:25)



TETRA TECH INC.

BORING LOG

Date: 11/19/98

Location: Upgradient

Logged By: S. Reinholtz

Hole No.: MW-6

Project No.: 10052-01

Project:

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of 4

Dist. from Surf.	Water Sample Interval	Water Sample No.	USCS	Log of Material	Remarks
60			SM	@ 60' - 65': Silty Sand; fine to coarse with some gravel; dense; wet.	Sci HS 61' - 29': 2 62' - 70': 6 63' - 38': 9 64' - 90': 10 65' - 90': 58
65			ML	@ 65' - 68': Silt, Sandy; strong brown fine to coarse (mostly fine); wet; dense.	66': - 450 ppm 110 67': - 1,000 ppm 22 68': - 7,100 ppm 97 69': - 600 ppm 100 70': - 71,000 ppm 75
			SM	@ 68' - 70': Sand, Silty; fine to coarse, dark staining from weathering mafics; some feldspar grains; clayey (white).	O.C. at 70': 9:20
70			NR	@ 70' : Lost core.	
				62' - 75'	
			ML/SM	@ 72' : Silt, Sandy; Sand, Silty; fine to coarse; strong brown micaceous; moderately dense; very moist.	72': - 9.5 ppm 85 73': - 9.5 ppm 95 74': - NR 95 75': - NR 120
75			SM	@ 75' - 80': Sand, Silty; fine to medium dense; moist; slight plasticity.	(76'): 60 ppm 60 (77'): 42 ppm 18 (78'): 9 ppm 60 (79'): 30 ppm 6 (80'): 22 ppm 4 O.C. - 80 (12:30)
80			ML	@ 80': Silt, Sandy; fine to medium dense; moist; a few coarse.	



TETRA TECH INC.

BORING LOG

Date: 11/22/98

Location: Cross-gradient

Logged By: R. Doss

Hole No.: MW-7

Project No.: 10052-01

Project: Site 12A (B-550)
Additional Site CharacterizationSheet 1
of 5

Dist. from Surf.	Water Sample Interval	Water Sample No.	USCS	Log of Material	Remarks
0			SW	Asphalt: 4"	Hand Augered to 5'
				@ 0-5': Sand, fine to coarse with silt (<10% silt), dark yellowish brown (10YR 4/4), dry, loose.	
					Screening (FID) HS (FID)
					(6'): 8 ppm NR
					(7'): 9 ppm NR
					(8'): 8 ppm NR
					(9'): 20 ppm NR
5					(10'): 21 ppm NR
			SM	@ 6' - 9': Silty Sand; fine to medium, minor coarse; dry; loose to moderately dense.	
			ML	@ 9' - 10': Sandy Silt; fine; yellowish brown (10YR 4/4), damp moderately dense.	(11'): 25 ppm NR
10				@ 10' - 15': Sandy Silt; same as above.	(12'): 40 ppm NR
					(13'): 30 ppm NR
					(14'): 80 ppm NR
					(25'): 180 ppm 30 ppm
15				@ 15' - 19': Sandy Silt; same as above except light olive brown (2.5YR 5/4); becomes coarser with depth.	(16'): 100 ppm NR
					(17'): 120 ppm NR
					(18'): 250 ppm 35 ppm
					(19'): 200 ppm NR
					(20'): 180 ppm 3 ppm
			SM	@ 19' - 20': Silty Sand; fine; iron oxide staining from weathering biotite; feldspar grains show high degree of weathering; very dense; damp.	
20					



TETRA TECH INC.

BORING LOG

Date: 11/22/98

Location: Cross-gradient

Logged By: R. Doss

Hole No.: MW-7

Project No.: 10052-01

Project: Site 12A (B-550)
Additional Site CharacterizationSheet 2
of 5

Dist. from Surf.	Water Sample Interval	Water Sample No.	USCS	Log of Material	Remarks
20			SM	@ 20' - 25': Silty Sand; fine to coarse; strong brown;	(21'): 1000+ ppm 30 ppm
				mottled light olive brown (2.5YR 5/4); very dense; damp.	(22'): 1000+ ppm 85 ppm
				Grains show evidence of severe weathering.	(23'): 1000+ ppm 35 ppm
					(24'): 750 ppm 20 ppm
					(25'): 100 ppm 40 ppm
25			ML	@ 25' - 27': Silty Sand; mostly fine, minor medium/coarse;	(26'): 1000+ ppm 40 ppm
				strong brown; mottled yellowish brown(10Y/R 5/4); very	(27'): 1000+ ppm 150 ppm
				dense; dry to slightly moist; becomes coarser with depth.	(28'): 180 ppm 80 ppm
					(29'): 660 ppm 25 ppm
			SM	@ 27' - 30': Silty Sand; very dense; dry to slightly moist.	(30'): 1000+ppm 50 ppm
30					
				@ 30' - 33': Silty Sand; same as above; very dense; moist.	(31'): 1000+ ppm 180 ppm
					(32'): 1000+ ppm 180 ppm
					(33'): 1000+ ppm 120 ppm
35					(34'): 1000 ppm 200 ppm
					(35'): 400 ppm 100 ppm
				@ 33' - 35': Sandy Silt; very dense; moist.	
40			NR	@ 35' - 39.5': No recovery.	
				@ 36': Possibly sand; fine to coarse with silt; loose.	
			ML	See next page.	



TETRA TECH INC.

BORING LOG

Date: 11/22/98

Location: Cross-gradient

Logged By: R. Doss

Hole No.: MW-7

Project No.: 10052-01

Project: Site 12A (B-550)
Additional Site CharacterizationSheet 3
of 5

Dist. from Surf.	Water Sample Interval	Water Sample No.	USCS	Log of Material	Remarks
40			ML	@ 40' - 41': Silty Sand; fine; dark yellowish brown (10YR 6/4).	(40'): 150 ppm 80 ppm (41'): 200 ppm 200 ppm
			SM	@ 41': Silty Sand; fine to coarse; moderately dense to loose; very moist; sand content increases with depth (80% sand).	(42'): 700 ppm 500 ppm (43'): 1000+ ppm 300 ppm (44'): 550 ppm 200 ppm (45'): 1000+ ppm 100 ppm
			↓		
			SW/SM		
			SM	@ 44' - 45': Silty Sand; fine (~30% silt); dense; moist.	
45			NR	@ 45' - 48': No recovery.	
		MW7-45W		From small sample: Same as above except loose; wet.	
					(49'): NR NR (50'): 450 ppm 2 ppm
			SM	@ 48' - 52': Silty Sand; fine to coarse (~20% silt); loose; wet; silt content and density increase with depth.	(51'): 400 ppm NR (52'): 200 ppm NR
50					
			ML/SM	@ 52' - 56': Silty Sand; fine (~40% silt); dark yellowish brown (10YR 6/4); loose; wet.	
				Becomes coarser with depth (~30% silt); loose; wet.	
					(54'): 40 ppm NR (55'): 25 ppm NR
55					(56'): 99 ppm 2 ppm
		MW7-58W	SW/SM	@ 56' - 58': Sand; fine to coarse with silt; and Sandy Silt; Coarse grains (quartz / feldspar) are relatively unaltered and set in a fine grained matrix.	(57'): 15 ppm NR (58'): 20 ppm NR
					(59'): 25 ppm NR (60'): 40 ppm NR (61'): 55 ppm 6 ppm (62'): 50 ppm NR
			SM	@ 58' - 62': Silty Sand; fine to coarse (~30% silt); dark yellowish brown (10YR 4/6); moderately dense; very moist.	
60					



BORING LOG

Logged By: R. Doss

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of 5

Dist. from Surf.	Water Sample Interval	Water Sample No.	USCS	Log of Material	Remarks	
60			SM			
			SM/SW	@ 62' - 63': Sand: fine to coarse with silt; moderately dense to loose; moist.	Screening	HS
			SM	@ 63' - 70': Silty Sand: fine to coarse; dense; moist.	(63'): 28 ppm	NR
					(64'): 50 ppm	NR
					(65'): 48 ppm	NR
					(67'): 66 ppm	18 ppm
65		MW7-65W			(68'): 32 ppm	NR
					(69'): 40 ppm	NR
70			SM/ML	@ 70' - 75': Sandy Silt. with Silty Sand: fine to medium, minor coarse; dark yellowish brown (10YR 4/6); moderately dense; moist.	(70'): 20 ppm	NR
					(71'): 20 ppm	NR
					(72'): 10 ppm	NR
					(73'): 18 ppm	NR
					(74'): 18 ppm	NR
					(75'): 22 ppm	3 ppm
				Sand content increases with depth.		
		MW5-74W				
75			SM/SW	@ 75' - 78': Silty Sand; fine to coarse (~20% silt); moderately dense; very moist.		
					(76'): 10 ppm	NR
					(77'): 8 ppm	NR
					(78'): 24 ppm	5 ppm
					(79'): 9 ppm	NR
			SM/ML	@ 78' - 80': Silty Sand and Sandy Silt; fine to medium; minor coarse; iron oxide staining from mica weathering.	(80'): 7 ppm	NR
80						



BORING LOG

Logged By: R. Doss

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of 5

Dist. from Surf.	Water Sample Interval	Water Sample No.	USCS	Log of Material	Remarks		
80			NR	@ 80' - 81': No recovery			
			SM	@ 81' - 83': Silty Sand; fine to coarse; moderately dense	(81'): 10 ppm	NR	
				to dense.	(82'): 20 ppm	NR	
					(83'): 15 ppm	NR	
					(84'): 18 ppm	3 ppm	
			SW/SM	@ 83' - 90': Sand; fine to coarse with silt; wet; loose;	(85'): 24 ppm	NR	
				interlayered with Silty Sand; fine to coarse; moderately	(86'): 22 ppm	NR	
				dense to loose; wet.	(87'): 20 ppm	NR	
					(88'): 20 ppm	NR	
85		MW7-85W			(89'): 24 ppm	NR	
				Becomes less silty with depth.			
90			SW				
			SM	@ 90' - 92': Silty Sand; fine.			
					(91'): 10 ppm	NR	
					(92'): 5 ppm	NR	
			ML	@ 92' - 96': Sandy Silt; fine dark stains from biotite	(93'): 5 ppm	NR	
				weathering; very dense; moist.	(94'): 10 ppm	NR	
					(95'): 15 ppm	NR	
95		MW7-95W					
			SM	@ 96' - 98.5': Sand, silty; fine to coarse, very dense; moist.	NR	NR	
			SW	@ 98.5' - 100': Sand; fine to coarse (~10-15% silt).			
100				T.D. = 100'BGS			



TETRA TECH INC.

BORING LOG

Date: 10-9-01

Location: MARB Site 550

Logged By: S. Hruby

Hole No.: 550 MW-10

Project No.: 1796-02

Project: MARB

Sheet 1
of 3

Dist. from Surf.	Blow Count	PID (ppm)	USCS	Log of Material	Remarks
0			ML	Asphalt	
5	5	0		sandy SILT: dark yellowish brown (10 YR 3/4): fine grained	Recovery 5"
	7		SW	sand: trace medium grained sand: dry: loose.	
	7				
10	3	0		SAND: dark grey (10 YR 4/1): well graded: dry: loose:	Recovery 16"
	4		ML	slight odor.	Fill sand?
	7				
15	32	0		SILT: brown (10 YR 4/3): trace coarse grained sand: trace	Recovery 16"
	50			gypsum flakes: dry: very hard: noticeable odor.	
	X				
20					



TETRA TECH INC.

BORING LOG

Date: 10-9-01

Location: MARB Site 550

Logged By: S. Hruby

Hole No.: 550 MW-10

Project No.: 1796-02

Project: MARB

Sheet 2
of 3

Dist. from Surf.	Blow Count	PID (ppm)	USCS	Log of Material	Remarks
20	10	8	ML	SILT: brown (10 YR 4/3): trace coarse grained sand: trace	Recovery 16"
	12			gypsum flakes: dry: very hard: noticeable odor.	
	22				
25			ML		
25	36	15	ML	SILT with SAND: dark greyish brown (10 YR 4/2): medium	Recovery 11"
	24			grained sand: trace coarse grained sand: trace gypsum	
	X			flakes: very hard: noticeable odor.	
30			ML		
30	20	25	ML	SILT: dark brown (10 YR 3/3): trace fine grained sand:	Recovery 18"
	13			hard: noticeable odor.	
	30				
35			ML		
35	23	250	ML	SILT with SAND: brown (10 YR 4/3): fine grained sand:	Recovery 18"
	28			trace medium grained sand: hard: noticeable odor.	
	40				
40					



TETRA TECH INC.

BORING LOG

Date: 10-9-01

Location: MARB Site 550

Logged By: S. Hruby

Hole No.: 550 MW-10

Project No.: 1796-02

Project: MARB

Sheet 3
of 3

Dist. from Surf.	Blow Count	PID (ppm)	USCS	Log of Material	Remarks
40	21	25	ML	SILT with SAND: brown (10 YR 4/3): fine grained sand;	Recovery 16"
	29			trace medium grained sand: dry: hard: noticeable odor.	
	32				
					Water
45			SW		
	9	60		SAND: dark greyish brown (10 YR 4/2): medium to coarse	Recovery 16"
	19			grained: well graded: wet: dense: noticeable odor.	
	22				
50			ML		
	31	5		SILT: dark yellowish brown (10 YR 3/4): trace fine grained	Recovery 18"
	40			sand: moist: hard: noticeable odor.	
	50				
55			ML		
	26	5		SILT with SAND: brown (10 YR 4/3): medium grained	Recovery 18"
	49			sand: trace coarse grained sand: moist: hard: noticeable	
	50			odor.	
60		NA		TD=60.0' BGS	No recovery



TETRA TECH INC.

BORING LOG

Date: 10-9-01		Location: MARB Site 550		Logged By: S. Hruby	
Hole No.: 550 MW-11		Project No.: 1796-02		Project: MARB	
				Sheet 1 of 4	
Dist. from Surf.	Blow Count	PID (ppm)	USCS	Log of Material	Remarks
0					
5	14	0	SP	SAND with SILT; dark yellowish brown (10 YR 4/4);	Recovery 18"
	19			medium grained sand with some silt; trace coarse grained	
	29			sand; medium dense.	
10	13	0	ML	SILT with SAND; yellowish brown (10 YR 5/4); medium	Recovery 18"
	25			grained sand; dry; firm.	
	50				
15	20	0	ML	SILT with SAND; yellowish brown (10 YR 5/4); medium	Recovery 17"
	40			grained sand; dry; firm.	
	50				
20					



TETRA TECH INC.

BORING LOG

Date: 10-9-01

Location: MARB Site 550

Logged By: S. Hruby

Hole No.: 550 MW-11

Project No.: 1796-02

Project: MARB

Sheet 2
of 4

Dist. from Surf.	Blow Count	PID (ppm)	USCS	Log of Material	Remarks
20	23	0	SP	SAND with SILT; dark brown (10 YR 3/3); trace coarse	Recovery 11"
	50			grained sand; poorly graded; dry; dense.	
25	31	0	SP	SAND with SILT; dark brown (10 YR 3/3); trace coarse	Recovery 18"
	42			grained sand; poorly graded; dry; dense.	
	50				
30	27	0	SP	SAND with SILT; dark brown (10 YR 3/3); trace coarse	Recovery 17"
	30			grained sand; poorly graded; dry; dense.	
	50				
35	27	0	SP	SAND with SILT; dark brown (10 YR 3/3); trace coarse	Recovery 18"
	38			grained sand; poorly graded; dry; dense.	
	50				
40					



TETRA TECH INC.

BORING LOG

Date: 10-9-01

Location: MARB Site 550

Logged By: S. Hruby

Hole No.: 550 MW-11

Project No.: 1796-02

Project: MARB

Sheet 3
of 4

Dist. from Surf.	Blow Count	PID (ppm)	USCS	Log of Material	Remarks
40	45	0	ML	SILT with SAND: brown (10 YR 4/3): medium grained	Recovery 18"
	42			sand: trace coarse grained sand: dry: hard.	
	48				
					Water
45	42	0	SW	SAND: brown (10 YR 4/3): medium to coarse grained: well	Recovery 18"
	50			graded: wet: dense.	
	X				
50	28	0	ML	SILT with SAND: brown (10 YR 4/3): fine grained sand;	Recovery 18"
	50			trace medium grained: moist: dense.	
55	49	0	ML	SILT with SAND: brown (10 YR 4/3): fine grained sand;	Recovery 10"
	50			trace medium grained: moist: dense.	
	X				
60					



Date: 10-9-01

Location: MARB Site 550

Logged By: S. Hruby

Hole No.: 550 MW-11


Project No.: 1796-02

Project: MARB

Sheet 4
of 4

Dist. from Surf.	Blow Count	PID (ppm)	USCS	Log of Material	Remarks
60	71	NA		No recovery; mud.	No recovery
				TD=61.0' BGS	
65					
70					
75					
80					

550 MW12

 MONTGOMERY WATSON										Bldg 550 site 550 MW8 550 MW12 ROAD ↑ N Site Sketch Map										Boring #: MW# 550 MW12 Sheet 1 of 4 Project: March ARB, Bldg 550 Well Installation Job #: 1950899.13140605 Site: Building 550 Logged By: J. Wiley Reviewed By: Drilling Contractor: Vinnex Drill Rig Type/Method: CME-75 / HSA Drillers Name: Michael Miller Borehole Diam./Drill Bit Type: 8" pilot, ream with 10" Total Depth: 64.5' Ref. Elev. NM Sampler Type: 1 1/4" ID split spoon & core barrel Drill Start Time/Date: 01/27/03 0850 Drill Finish Time/Date: 01/27/03 1530 Well Completion Time/Date: 01/29/03 Soil Boring Backfill Time/Date: NA									
Depth to 1st Water (V): 31.3 Time/Date: 01/27/03 1113 Depth to Water After Drilling (V): Time/Date: Depth to other Water Bearing Zones: During drilling, soil wet at 39' and 54'.																													
PID/OVA	Sample Interval	Recovered (in.)	Blow Counts / 6 in.	Retained for Analysis	Casing Type & Size	Annulus Filler	Depth (Feet)	USCS Soil Type	Soil Description	Estimated % Of																			
										Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt/clay															
							1		Soil at surface.																				
							2		Hand auger to 5' bgs.																				
							3																						
							4																						
0.6	X	X	29				5	SM	SILTY SAND (SM), yellowish brown (10YR 5/4), very dense, moist, fine to coarse sand, areas of white calcite cementation, no odor, subangular grains.	5	15	65	15	0															
			50				6																						
							7																						
							8																						
0.5	X	X	19				9	SP SM	SAND with SILT (SP-SM), yellowish brown (10YR 5/4), dense, moist, fine to coarse sand, no odor, subrounded grains, noncemented.	5	35	60	10	0															
			22				10																						
			24				11																						
							12																						

550MW12

Boring #:		MW#: 550MW12		Project: March ARB, Building 550 Woods		Sheet 2 of 4									
PID/QVA	Sample Interval	Recovered (in.)	Blow Counts / 6 in.	Retained for Analysis	Casing Type & Size	Annulus Filler	Depth (Feet)	USCS Soil Type	Soil Description	Gravel	Estimated % Of Sand			Silt/Clay	
							12								
							13								
0.2	X	X	20				14	SP	SAND(SP), light yellowish brown (10YR 6/4), dry to moist, very dense, loose sand, fine to coarse sand, noncemented, no odor, subrounded grains.		5	80	15	4%	
			22				15								
			28				16								
							17								
							18								
0.3	X	X	38				19		Same, dark yellowish brown (10YR 4/4), moist, noncemented but not loose sand, etc.		10	50	35	5% in	
			50				20								
							21								
							22								
							23								
							24	SM	SILTY SAND(SM), dark yellowish brown (10YR 6/6), moist, cemented in areas, tightly packed, very dense, fine to coarse sand, no odor, subrounded grains.		5	25	55	15%	
0.1	X	X	22				25								
			29				26								
			34				27								
							28								
							29		same, coarser - varies from fine sand to coarse end of med. sand, tr. coarse, dark yellowish brown (10YR 3/6), tr. areas of cementation, tightly packed, subrounded grains, tr. clay.		tr	40	45	15% ex. tr	
0.2	X	X	24				30								
			26				31								
			29				32								

QWOC

550 MW 12

Boring #:		MW#: 550 MW 12		Project: March ARB, Building 550 Wells		Sheet 3 of 4								
PID/VA	Sample Interval	Recovered (in.)	Blow Counts / 6 in.	Retained for Analysis	Casing Type & Size	Annulus Filler	Depth (Feet)	USCS Soil Type	Soil Description	Gravel	Estimated % of Sand			Silt/Clay
											Coarse	Med.	Fine	
					SP	blank	32							
							33							
							34	SP	SAND(SP), dark yellowish brown (10YR 4/6), very dense, moist, fine to coarse grained, tr. silt (~5%), weakly cemented throughout, no odor, subrounded grains (granitic) to subangular grains.		10	45	40	5%
0.1			38				35							
			50				36							
							37							
							38							
							39		(Hydropunch interval) 550 MW 12-GW-37					
0.0			27				40		same, wet at top of sampler, moist to wet at bottom of sampler, fine to medium sand w/ ~5% silt					
			34				41	SP	noncemented, no odor, subrounded grains.		15	80		5%
			42				42		@40', more coarse grains, wet (almost SW, 10% coarse as at 35')					
							43		@42', moist to wet, finer (tr. coarse sand, 20% med., 80% fine, tr. silt)					
							44		@44'-45' wet slough.					
0.0							45		@45'-46.5' wet to saturated in areas - Soil as at 35'.		10	45	40	5%
							46							
							47	SM	SILTY SAND(SM), dark yellowish brown (10YR 4/6), moist, tightly packed - very dense, fine to medium sand, tr. coarse sand, cemented in some areas, no odor, subrounded.		tr	15	70	15%
							48							
							49				tr	15	70	15%
0.0							50		same, areas of cementation @ 49'-50' moist only, very tight.					
							51							
							52							

550MW12

Boring #:		MW#: 550MW12		Project: March ARB Bldg 550		Sheet 4 of 4								
PID/VA	Sample Interval	Recovered (in.)	Blow Counts / 8 in.	Retained for Analysis	Casing Type & Size	Annulus Filler	Depth (Feet)	USCS Soil Type	Soil Description	Gravel	Estimated % of Sand			Silt/Clay
							52	SP-SM	SAND with SILT (SP-SM), light yellowish brown (10YR 6/4), dense, moist, non-to weakly cemented in areas, subrounded to subangular.		5	35	50	1%
							53							
							54							
							55	SP	SAND (SP), dark yellowish brown (10YR 4/4), wet, loose, fine to med sand - med sand on fine side, noncemented.			50	50	tr
							56							
							57							
							58		(Hydropunch interval) 550MW12-GW-57					
							59							
							60		SLough at 60', no sample.					
							61							
							62							
							63							
							64	SM	SILTY SAND (SM) with ~5% clay, yellowish brown (10YR 5/4), moist, very tight & cohesive, fine to med. sand, noncemented, fr. coarse sand, no odor, subangular.		tr	25	50	20%
							65							
							66							
							67							
							68							
							69		Terminate borehole at 64.5 fgs. Construct groundwater monitoring well.					
							70							
							71							
							72							

550MW13

MONTGOMERY WATSON								Boring #: MW#: 550MW13 Sheet 1 of 4						
Site Sketch Map								Project: March ARB, Bldg 550 Well Installation						
								Job #: 1950899.13140605 Site: Building 550						
								Logged By: J. Wiley Reviewed By: Warner						
								Drilling Contractor: Vironex						
								Drill Rig Type/Method: CME-75 / HSA						
								Drillers Name: Michael Miller						
								Borehole Diam./Drill Bit Type: 6" pilot / 10" ream						
								Total Depth: 65.0'						
								Ref. Elev. NM						
								Sampler Type: 1.4" ID split spoon & continuous coring						
Depth to 1st Water (Σ): 31.7' Time/Date: 01/28/03 1545								Drill Start Time/Date: 01/28/03 0830 Drill Finish Time/Date: 01/28/03 1722						
Depth to Water After Drilling (▽): Time/Date:								Well Completion Time/Date: 01/30/03						
Depth to other Water Bearing Zones: During drilling soil wet at 39', 50', and 59'.								Soil Boring Backfill Time/Date: N/A						
PID/OVA	Sample Interval	Recovered (in.)	Blow Counts / 6 in.	Retained for Analysis	Casing Type & Size	Annulus Filler	Depth (Feet)	USCS Soil Type	Soil Description	Estimated % Of				
										Gravel	Coarse	Medium	Fine	Silt/clay
							1		Soil at surface.					
							2		Hand auger to 5' bgs.					
							3		Difficult to hand auger.					
							4	SP						
							5		SAND (SP), yellowish brown (10YR 5/4),			20	80	tr / %
							6		very dense, dry, fine to medium sand,					
							7		cemented or extremely hard & tight,					
							8		no odor, tr. root casts.					
							9							
							10	?	No Recovery - very hard drilling					
							11							
							12							

Site Sketch Map: 550MW12, 550MW13, N

Handwritten notes: 4" sch 40 PVC blank for hard cement (50' to 59')
 No Recovery 50' for 4"
 0.0 X 53
 NM X

550MW13

Boring #:		MW# 550MW13		Project: March ARB, Building 550		Sheet 2 of 4		Estimated % Of Sand						
PID/VA	Sample Interval	Recovered (in.)	Blow Counts / 6 in.	Retained for Analysis	Casing Type & Size	Annulus Filler	Depth (Feet)	USCS Soil Type	Soil Description	Gravel	Coarse	Med.	Fine	Silt/Clay
							12							
							13							
							14	SW	SAND (SW), dark yellowish brown (10YR 4/4), dry to moist, very dense, fine to coarse sand, noncemented, no odor, subrounded granitic grains, tr. silt	30	35	35	tr	%
0.0	X	X	22				15							
			24				16							
			30				17							
							18							
							19	SP	SAND (SP), brownish yellow (10YR 6/6), very dense, dry, fine to medium sand, very tight and partly cemented, tr. silt, no odor	50	50	tr	%	
0.0	X	X	34				20							
			50				21							
							22							
							23							
							24		same. Hard drilling	50	50	tr	%	
0.0	X	X	53				25							
							26							
							27							
							28							
							29	SW	SAND (SW), dark yellowish brown (10YR 3/4), very dense, moist, fine to coarse sand, weakly cemented, no odor, subrounded granitic grains, tr. silt	25	35	40	tr	%
0.0	X	X	38				30							
			50				31							
							32							

4" Sch 40 PVC blank

Per Hand Cement Grout (5 to 6 in dia)

GNOC

550 MW13

Boring #:		MW#: 550 MW13		Project: March ARB Building SEO		Sheet 3 of 4									
PID/VA	Sample Interval	Recovered (in.)	Blow Counts / 6 in.	Retained for Analysis	Casing Type & Size	Annulus Filler	Depth (Feet)	USCS Soil Type	Soil Description	Gravel	Estimated % Of Sand				Silt/Clay
							32								
							33	SP-SM							
0.1			12 14 20		Sch 40 PVC	Med Bent Chunks	34		SAND with SILT (SP-SM), dark yellowish brown (10YR 4/4), dense, moist, fine to med sand, tr. cse. sand, noncemented, no odor, subrounded grains. Easier drilling		tr	30	70	10%	
					blank		35								
							36								
							37								
							38								
0.2			16 20 28		Sch 40 PVC		39		Mud in upper 3 inches SAME, very moist to wet from 39.25'-40'		tr	30	70	10%	
							40		(Hydropunch interval) - 550 MW13-GW-40						
							41		SAME, wet to ~41. Moist to wet at ~42-43'	10	30	30	30	tr%	
0.2					Sch 40 PVC		42		SAND (SW) with Gravel, dark yellowish brown (10YR 4/4), wet (saturated), fine to coarse sand with gravel, tr. silt, noncemented, no odor, subangular to subrounded granitic grains. Moist to wet in last inch.						
					Sch 40 PVC		43								
					Sch 40 PVC		44								
					Sch 40 PVC		45								
0.2					Sch 40 PVC		46	SM	SILTY SAND (SM), dark yellowish brown (10YR 3/4), moist, fine to med. sand (on fine side), tr. cse. sand and gravel, noncemented, no odor.	tr	tr	40	40	20%	
					Sch 40 PVC		47								
					Sch 40 PVC		48								
					Sch 40 PVC		49		@49.5'-50' moist to wet.						
					Sch 40 PVC		50	SW	SAND (SW) with gravel, dark yellowish brown (10YR 4/4), wet (saturated), fine to cse. sand with gravel and occasional	15	30	30	25	tr%	
					Sch 40 PVC		51								
					Sch 40 PVC		52								

550 MW13

Boring #:		MW#: 550MW13		Project: March ARB Building 550		Sheet 4 of 4								
PID/OVA	Sample Interval	Recovered (in.)	Blow Counts / 6 in.	Retained for Analysis	Casing Type & Size	Annulus Filler	Depth (Feet)	USCS Soil Type	Soil Description	Gravel	Estimated % Of Sand			Silt/Clay
											Coarse	Med.	Fine	
							52	SW	rocks to 1.5" diam, noncemented, no odor, subrounded to subangular					
							53	SP	SAND with SILT (SP7SM), yellowish brown (10YR 5/6), moist, tightly packed, fine to medium sand, 5% cse sand	tr	5	20	65	10%
							54	SM	noncemented, no odor, tr. gravel, @ 55.5', tr. clay, no gravel, light olive brown (2.5Y 5/4)	0	tr	25	65	10%
							55							
							56							
							57							
							58							
							59		brown (7.5YR 4/4), wet (saturated), with 5% gravel.	5	5	40	40	10%
							60							
							61		(Hydropunch interval) 550MW13-BW-61					
							62	SM	SILTY SAND (SM), brown (7.5YR 4/4), moist, fine to medium sand, tr. coarse sand, noncemented, no odor.	0	tr	20	65	15%
							63							
							64							
							65		Terminate borehole at 65' bgs. Construct groundwater monitoring well.					
							66							
							67							
							68							
							69							
							70							
							71							
							72							

MONTGOMERY WATSON <p style="text-align: center;">Site Sketch Map</p>		Boring #: A MW#: 550MW14 Sheet 1 of 4												
		Project: March ARB, Moreno Valley, CA Job #: 1950899.13550000 Site: Bldg 550 Logged By: J. Wilky Reviewed By: M. L. ... Drilling Contractor: Vironex Drill Rig Type/Method: CME-75 / HSA Drillers Name: Chris Vargas Borehole Diam./Drill Bit Type: 8" pilot / 10" ream Total Depth: 62' Ref. Elev.: NM												
Depth to 1st Water (▽): Between 41' - 43' 44' Time/Date: 05/27/03 1300		Drill Start Time/Date: 0835 Drill Finish Time/Date: 1740												
Depth to Water After Drilling (▽): 38.15' Time/Date: 05/27/03 1340		Well Completion Time/Date: NA												
Depth to other Water Bearing Zones: Between 55' - 59.5'		Soil Boring Backfill Time/Date: 05/28/03 0836												
PID/OVA	Sample Interval	Recovered (in.)	Blow Counts / 6 in.	Retained for Analysis	Casing Type & Size	Annulus Filler	Depth (Feet)	USCS Soil Type	Soil Description	Estimated % Of				
										Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt/clay
									no well completion					
							1		Soil & weed surface.					
							2		Hand auger to 5' bgs.					
							3							
							4							
							5	SP	SAND (SP), dark yellowish brown (10YR 4/4), very dense, moist, fine to med. sand, tr. coarse sand, tr. silt, noncemented, organic odor, sub rounded grains.	tr	30	70	tr	0
							6							
							7							
							8							
							9							
							10	SP	same, yellowish brown (10YR 5/4), no odor, dense.	tr	40	60	tr	0
							11							
							12							

550 MW 14 - A

Boring #:		MW#: 550 MW 14		Project: March ARB, Bldg 550		Sheet 2 of 4								
PID/OVA	Sample Interval	Recovered (in.)	Blow Counts / 8 in.	Retained for Analysis	Casing Type & Size	Annulus Filler	Depth (Feet)	USCS Soil Type	Soil Description	Gravel	Estimated % of Sand			Silt/Clay
							2	SP						
							3							
							4							
0.4	X	X	4				15	SM	SILTY SAND (SM), dark yellowish brown (10YR 4/4), medium dense, moist, fine to med. sand, noncemented, no odor, subangular to subrounded grains.		10	75	15	%
			8				6							
			16				7							
							8							
							9							
0.8	X	X	8				20	SM	same, very dense.		20	65	15	%
			18				1							
			30				2							
							3							
							4							
0.4	X	X	21				25	SW	SAND (SW), dark yellowish brown (10YR 4/4), very dense, moist, fine to coarse sand, tr. silt, weakly cemented in areas, no odor, subangular to subrounded grains.		30	30	40	tr %
			18				6							
			32				7							
							8							
							9							
0.8	X	X	18				30	SP	SAND (SP), dark yellowish brown (10YR 4/4) with trace black spots, very dense, moist, fine to coarse sand, tr. silt, weakly cemented, no odor, subang to subround.	5	60	35	tr %	
			21				1							
			32				2							

portland cement grout

550 MW14-A

Boring #:		MW#: SSD MW14		Project: March ARB, Bldg. 550		Sheet 3 of 4								
PID/OVA	Sample Interval	Recovered (in.)	Blow Counts / 6 in.	Retained for Analysis	Casing Type & Size	Annulus Filler	Depth (Feet)	USCS Soil Type	Soil Description	Gravel	Estimated % Of Sand			Silt/Clay
							2	SP						
							3							
							4							
0.5	X	X	21				35	SP-SM	SAND with SILT (SP-SM), yellowish brown (10YR 5/4), very dense, moist, fine to medium sand, tr. coarse sand, noncemented, no odor, subang. to subbrown grains		tr	45	45	1%
			28				6							
			50 for 4'				7							
							8							
							9							
0.5	X	X	14				40	SP-SM	same, dark yellowish brown (10YR 4/4), moist to very moist in areas.		5	35	50	1%
			26				1							
			40				2							
							3							
							4							
0.3	X	X	15				45	SM	SILTY SAND (SM), dark yellowish brown (10YR 4/6), very dense, very moist, wet at top of sample (thick mud in top 3")		tr	30	55	15%
			24				6							
			40				7	SP-SM	fine to med sand, tr. coarse sand, noncemented, no odor, subang. to subbrown grains		tr	30	30	30%
0.4	X	X					8	SP-SM	HydroPursh Interval, 550 MW14 - 6' W-45					
0.2	X	X					9	SP-SM	46.5' SAND with SILT (SP-SM), yellowish brown (10YR 5/4), wet but not said-moist in areas, fine to coarse sand, noncemented, no odor, subang. to subbrown grains					
0.5	X	X					50							
							1							
							2							

550 MW 14-A

Boring #:		MW# 550 MW 14		Project: March ARB, Bldg. 550		Sheet 4 of 4								
PID/OVA	Sample Interval	Recovered (in.)	Blow Counts / 6 in.	Retained for Analysis	Casing Type & Size	Annulus Filler	Depth (Feet)	USCS Soil Type	Soil Description	Gravel	Estimated % Of Sand			Silt/Clay
0.5							2	SP-SM	same, moist to very moist, fine to med sand.		10	80	10%	
0.5							3							
0.5							4		same		10	80	10%	
0.5							5	SP	SAND (SP), yellowish brown (10 YR 5/4), moist only, fine to med. sand, noncemented, no odor, subang-subang.		20	70	10%	
							6							
							7		Poor Recovery 55'-59', soil change to wet, muddy cuttings during drilling.					
							8							
0.5							9	SP	same, SAND (SP), yellowish brown (10 YR 5/4), wet (saturated-muddy), fine to med sand, noncemented, no odor, subang-subang.	90	10	10%		
0.4							60		last 4" fine to coarse sand, wet, but not muddy - still intact.	5	40	55%		
							1		@ 60', same, moist to very moist, tr. areas of cementation.	10	90	10%		
							2							
							3							
							4		Hydropunch interval - no water recovery					
							65		Terminate borehole at 62' due to refusal. Pushed hydropunch to 65' until refusal. No water.					
							6							
							7							
							8							
							9							
							70							
							1							
							2							

<p style="text-align: center;">Site Sketch Map</p>										Boring #: B MW#: 550 MW 14 Sheet 1 of 4				
										Project: March ARB, Moreno Valley, CA				
										Job #: 195899.1380000 Site: Bldg 550				
										Logged By: J. Wiley Reviewed By:				
										Drilling Contractor: Virrexx				
										Drill Rig Type/Method: CME-75/HSA				
Drillers Name: Chris Vargas										Total Depth 55'				
Borehole Diam./Drill Bit Type: 8" pilot hole / 10" ream										Ref. Elev. NM				
Sampler Type: 5' core barrel														
Depth to 1st Water (V): between 35'-41' Time/Date: 05/28/03 1335										Drill Start Time/Date: 05/28/03 1017		Drill Finish Time/Date: 05/28/03 1120		
Depth to Water After Drilling (V): NM Time/Date:										Well Completion Time/Date:				
Depth to other Water Bearing Zones: 35-51' (bun)										Soil Boring Backfill Time/Date:				
PID/OVA	Sample Interval	Recovered (in.)	Blow Counts / 6 in.	Retained for Analysis	Casing Type & Size	Annulus Filler	Depth (Feet)	USCS Soil Type	Soil Description	Estimated % Of				
										Gravel	Coarse	Medium	Fine	Silt/clay
							1		Soil & weed surface Hand auger to 5' bgs					
							2							
							3							
							4							
							5	SP	SAND with SILT (SP-SM), dark yellowish brown (10YR 4/6), moist, fine to medium sand, tr. coarse sand, noncemented, organic odor, trace roots, subangular grains	tr	20	70	10	0
							6							
							7							
							8							
							9							
							10		same, weakly cemented, subangular to subrounded grains, slight odor	tr	40	50	5	5
							11	SP	SAND (SP), dark yellowish brown (10YR 4/6), moist, fine to medium sand, tr. coarse sand, noncemented, slight organic odor, subangular to subround grains	tr	40	55	tr	0
							12							

550 MW14 -B

Boring #:		MW#:	Project:	Sheet	of									
		550 MW 14	Building 550, March ARB	2	4									
PID/OVA	Sample Interval	Recovered (in.)	Blow Counts / 6 in.	Retained for Analysis	Casing Type & Size	Annulus Filler	Depth (feet)	USCS Soil Type	Soil Description	Gravel	Estimated % Of Sand			Silt/Clay
											Coarse	Med.	Fine	
							2	SP						
							3		harder					
0.6							4	SP-SM	sand with SILT (SP-SM), dark yellowish brown (10 & 2 1/4), dry to moist, fine to med sand, tr cse sand, weakly cemented, subrounded.		tr 20	70	1%	
							15							
							6							
							7		(hard drilling 15'-20')					
0.6							8							
							9		same, areas of cementation throughout & calcite nodules, moist.		tr 40	50	1%	
							20							
							1	SW	sand (SW), dark yellowish brown (10 & 2 1/4), moist, fine to coarse sand, tr. gravel, tr. silt, areas of weak cementation, subangular to subrounded grains.	tr	35	35	30	tr%
							2							
							3							
							4		(hard drilling 20'-25')					
0.5							25		same	tr	35	35	30	tr%
							6	SW						
							7		(hard drilling 25'-30')					
							8	SP	sand (SP) dark yellowish brown (10 & 2 1/4) mottled with areas of pale yellow (5 & 7 1/3), dry to moist, fine to med sand, tr. silt, weakly cemented.			20	80	tr%
							9	SW	Same as 20.5'	tr	35	35	30	tr%
0.6							30	SP-SM	same as 13.5', moist, noncemented.		5	25	60	tr%
							1							
							2		same, spots of very moist, (only in a band of ~ 6 inches)		5	25	60	tr%

550 MW14-B

Boring #:		MW#: 550 MW14		Project: Building 550 March ARB		Sheet 3 of 4									
PID/VA	Sample Interval	Recovered (in.)	Blow Counts / 6 in.	Retained for Analysis	Casing Type & Size	Annulus Filler	Depth (Feet)	USCS Soil Type	Soil Description	Gravel	Estimated % of Sand				Silt/Clay
											Coarse	Med.	Fine		
							2	SP							
							3	SM							
0.5							4		same, weakly cemented with small gravel sized cemented siltstone nodules throughout, moist only.		20	70	10	%	
							35								
							6	SP							
							7		SAND(SP), dark yellowish brown (10 yr 4/4), moist to wet, fine to med sand, tr. (se sand		tr 35	65	tr	%	
							8		tr. silt, noncemented, no odor.						
							9		Note: sample VERY HOT (temp) to touch						
0.4							40								
							1		Same, mud in upper 2 inches		tr 35	65	tr	%	
							2	SP	Hydropunch collected 550 MW14 B-6W-41						
							3		All watery mud from 3'-4.25'						
							4	SM	SILTY SAND (SM), dark yellowish brown (10 yr 4/4), very moist to wet, fine to med sand, tr. (se sand, noncemented, no odor		tr 30	55	tr	%	
0.6							45								
							6		same, very moist		tr 30	55	tr	%	
							7		(hard drilling 45'-50')						
							8	SW	SAND(SW), dark yellowish brown (10 yr 4/4), wet, fine to cse sand, tr. gravel, tr. silt, noncemented, no odor, subrounded.		tr 30	35	35	tr %	
							9	SP	SAND(SP), dark yellowish brown (10 yr 4/4), very moist, fine to med. sand, tr. cse sand & silt, noncemented, no odor.		tr 20	80	tr	%	
0.9							50								
							1								
							2	SW							

ONOC

Q/NQC



TETRA TECH INC.

BORING LOG

Date: 10-9-01

Location: MARB Site 550

Logged By: S. Hruby

Hole No.: 550 EX-1

Project No.: 1796-02

Project: MARB

Sheet 1
of 4

Dist. from Surf.	Blow Count	PID (ppm)	USCS	Log of Material	Remarks
0				4" asphalt pavement.	
5	18	0	ML	Sandy SILT; yellowish red (5 YR 4/6): fine grained sand:	Recovery 18"
	18			trace coarse grained sand; dry; hard.	
	30				
10	22	0	ML	Sandy SILT; dark grey (5 YR 4/1): fine grained sand; trace	Recovery 16"
	22			coarse grained sand; dry; hard.	
	29				
15	31	0	ML	Sandy SILT; dark grey (5 YR 4/1): fine to medium grained	Recovery 17"
	45			sand; trace coarse grained sand; angular sand; quartz.	
	59			feldspar, trace mica; dry; very hard.	
20					



TETRA TECH INC.

BORING LOG

Date: 10-9-01

Location: MARB Site 550

Logged By: S. Hruby

Hole No.: 550 EX-1

Project No.: 1796-02

Project: MARB

Sheet 2
of 4

Dist. from Surf.	Blow Count	PID (ppm)	USCS	Log of Material	Remarks
20	12	0	ML	Sandy SILT: dark grey (5 YR 4/1); medium grained sand;	Recovery 17"
	16			trace coarse grained sand: quartz, feldspar, micas; dry; hard.	
	17				
25	19	0	ML	SILT: dark grey (5 YR 4/1); trace fine grained sand; dry;	Recovery 18"
	35			very hard.	
	50				
30	24	0	ML	Sandy SILT: dark yellowish brown (10 YR 3/4); fine	Recovery 18"
	48			grained sand; trace medium grained sand; dry; hard.	
	50			CLAY lens: dark yellowish brown (10 YR 3/4); very small;	
				trace.	
35	35	0	ML	Sandy SILT: brown (10 YR 4/3); fine grained sand; dry;	Recovery 13"
	50			very hard.	
40					



TETRA TECH INC.

BORING LOG

Date: 10-9-01

Location: MARB Site 550

Logged By: S. Hruby

Hole No.: 550 EX-1

Project No.: 1796-02

Project: MARB

Sheet 3
of 4

Dist. from Surf.	Blow Count	PID (ppm)	USCS	Log of Material	Remarks		
40	12	2	ML	Sandy SILT: yellowish brown (10 YR 5/4): fine grained	Recovery 18"		
	24			sand: trace medium grained sand: dry: hard.	Continuous coring from 40' bgs		
	25				to TD		
	16				Recovery 18"		
	16		ML	Sandy SILT: yellowish brown (10 YR 5/4): fine grained			
	30			sand: trace medium grained sand: dry: hard.			
	12				Water first encountered		
	34			Sandy SILT: brown (10 YR 4/3): fine grained sand: some	Recovery 18"		
	45	29		ML	medium to coarse grained sand: trace gravel; wet: hard;		
		19			noticeable gasoline odor.	Recovery 18"	
29							
29		169					
20			SW-SM	SAND with SILT: brown (10 YR 4/3): well graded sand:	Recovery 18"		
30				some silt: wet: hard.			
50							
22				141	SW-SM	SAND with SILT: brown (10 YR 4/3): well graded sand:	Recovery 18"
43		some silt: wet: hard.					
50							
39	No recovery	No recovery					
50	42				Hammer was stuck in the mud		
	22			229	SW	SAND: greyish brown (10 YR 3/2): medium to coarse	Recovery 18"
	43					grained: well graded: wet: medium dense.	
	50					177	
	15	147					
	24						
	40			ML	SILT with SAND: greyish brown (10 YR 3/2): fine grained	Recovery 18"	
	20				sand: moist: firm.		
	22	151					
	31						
55	25		SW	SAND: brown (10 YR 4/3): medium to coarse grained: well			
	30			graded: medium dense.			
	50						
	14						
	19	57					
	25						
	21						
	50			43			
	X						
	12						
60	40	49					



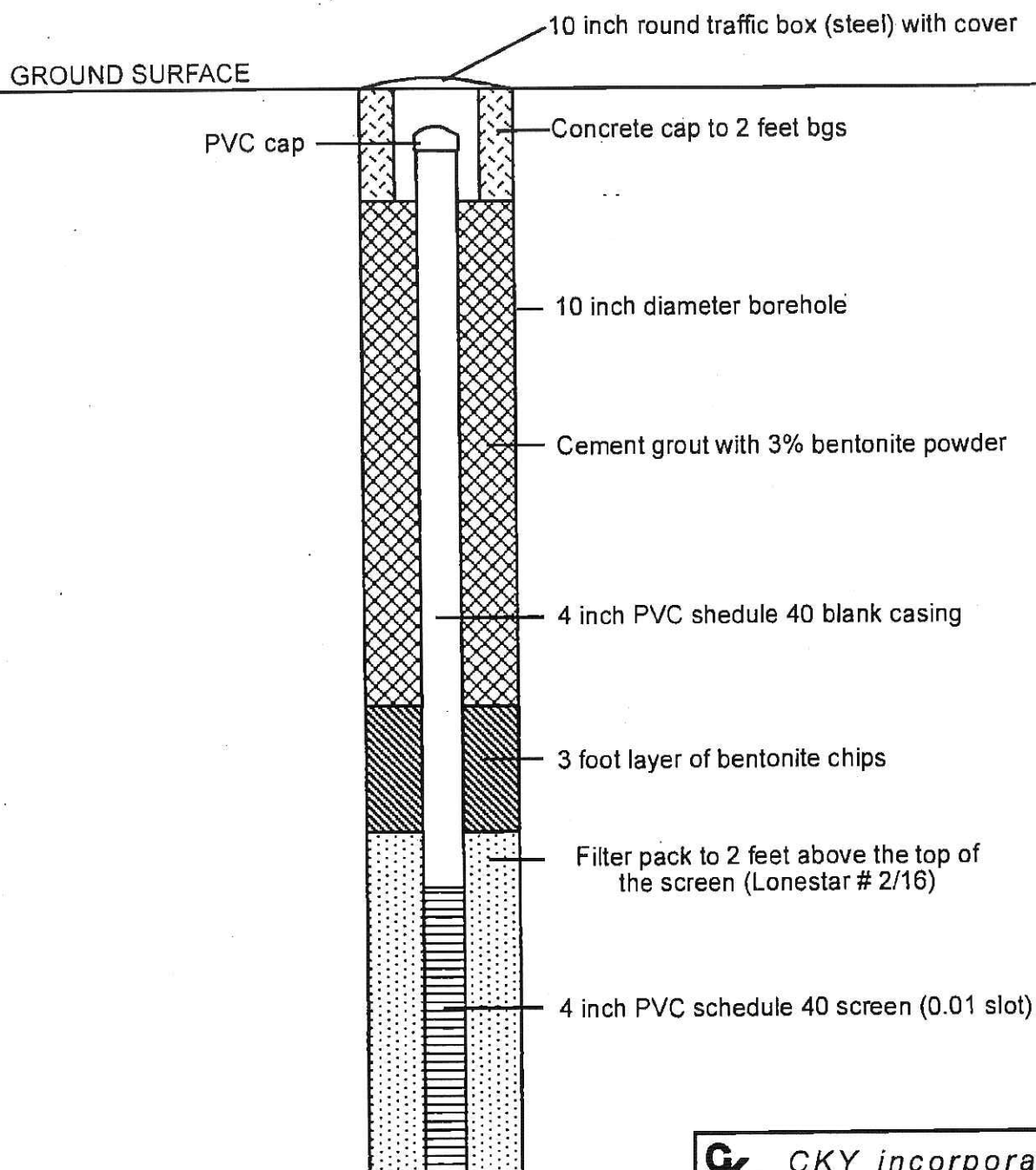
Date: 10-9-01	Location: MARB Site 550	Logged By: S. Hruby
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Hole No.: 550 EX-1	Project No.: 1796-02	Project: MARB	Sheet 4 of 4
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Dist. from Surf.	Blow Count	PID (ppm)	USCS	Log of Material	Remarks
60	40				
	50		ML	SILT: very dark greyish brown (10 YR 3/2): trace fine	Recovery 18"
	15			grained sand: moist: very hard.	
	29	99			
	50				
	17				
	34	66	ML	SILT: very dark greyish brown (10 YR 3/2): trace fine	Recovery 18"
	50			grained sand: moist: very hard.	
	19				
65	37	31	ML	Sandy SILT: very dark brown (10 YR 2/2): fine grained	Recovery 17"
	50			sand: trace medium grained sand: moist: very hard.	
	17				
	39	17			Recovery 18"
	49				
	19				
	36	5	ML	Sandy SILT: very dark brown (10 YR 2/2): fine grained	Recovery 16"
	50			sand: trace medium grained sand: moist: very hard.	
	X				
70	37	2	ML	Sandy SILT: very dark brown (10 YR 2/2): fine grained	Recovery 15"
	56			sand: trace medium grained sand: moist: very hard.	
	X				
	X				
				TD=71.0' BGS	
75					
80					

WELL CONSTRUCTION DIAGRAMS

550-MW1
550-MW2
550-MW3

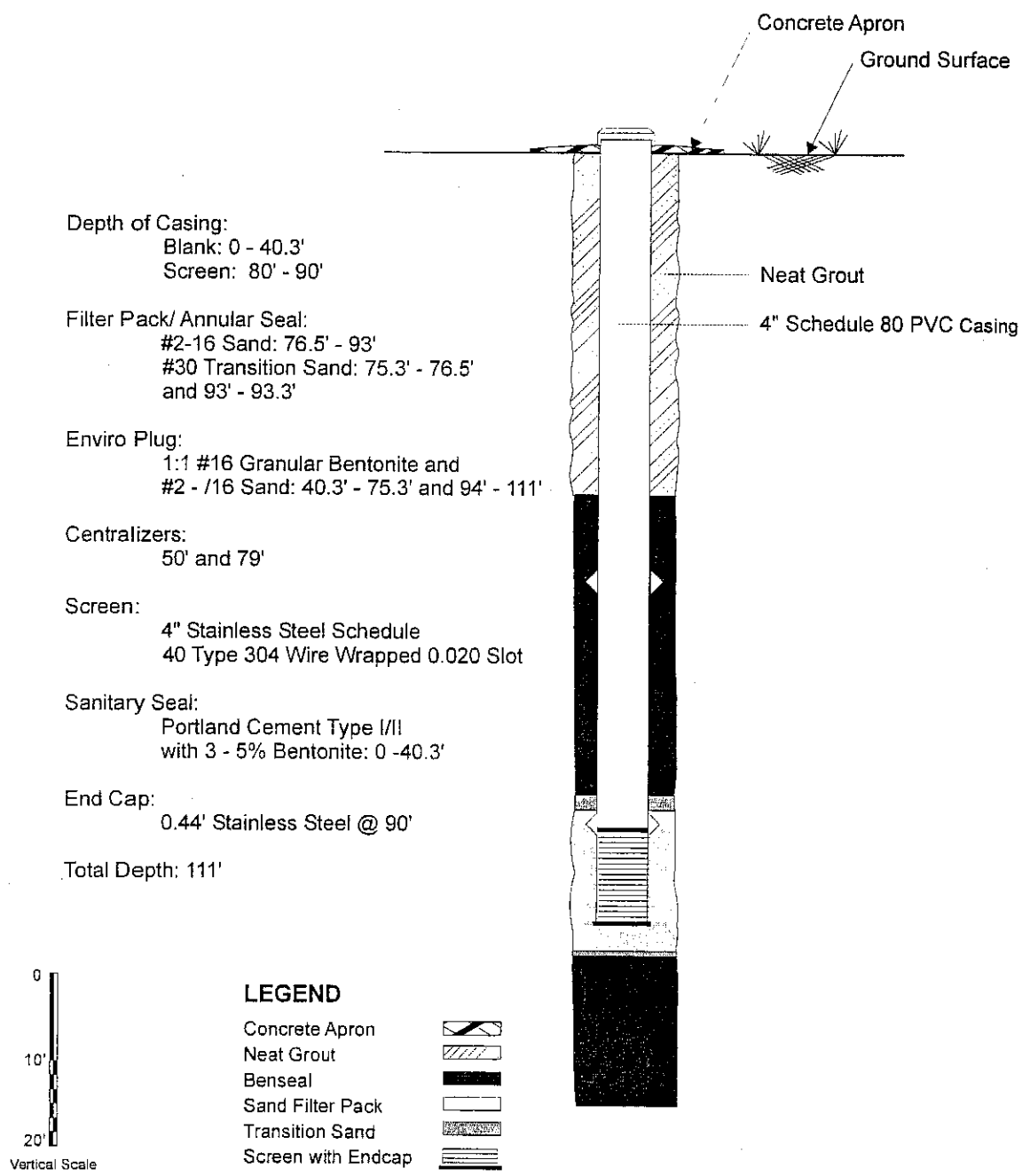


CKY *CKY incorporated*
Environmental Services

TYPICAL WELL CONSTRUCTION
SCHEMATIC

PROJECT NO. 9560

FIGURE 5



NOTES:

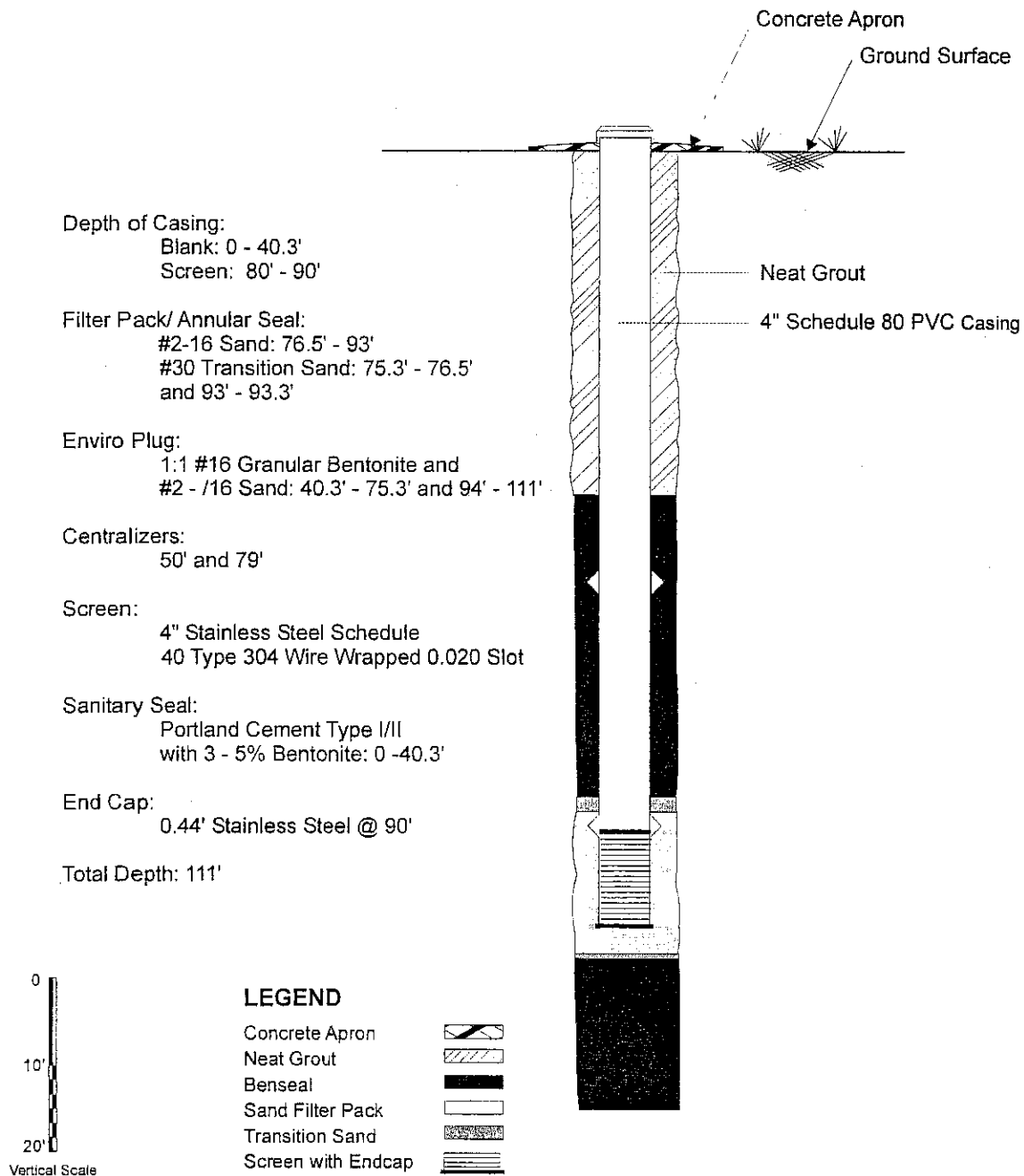
- All measurements are from below the ground surface in feet.
- Stainless steel centralizers placed above and below the screen and placed every 20 ft. along blank casing.
- Blank casing is Schedule 80 polyvinyl chloride (PVC); screen is Type 304 wire wrapped Schedule 40 stainless steel with 0.01 inch slot size.
- Top of casing is 2.5 feet above ground surface.

United States Air Force

March ARB

Monitoring Well
Construction Diagram
MW4

Figure



NOTES:

- All measurements are from below the ground surface in feet.
- Stainless steel centralizers placed above and below the screen and placed every 20 ft. along blank casing.
- Blank casing is Schedule 80 polyvinyl chloride (PVC); screen is Type 304 wire wrapped Schedule 40 stainless steel with 0.01 inch slot size.
- Top of casing is 2.5 feet above ground surface.

United States Air Force

March ARB

Monitoring Well
Construction Diagram
MW4

Figure

Depth of Casing:
 Blank: 0 - 39.3'
 Screen: 60' - 70'

Filter Pack/ Annular Seal:
 #2-16 Sand: 57' - 72.8'
 #30 Transition Sand: 56' - 57'
 and 72.8' - 74'

Enviro Plug:
 1:1 #16 Granular Bentonite and
 #2 - /16 Sand: 39.3' - 54'

Pellets, Medium Chips:
 54' - 56'

Enviro Plug Chips:
 74' - 90.5'

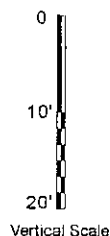
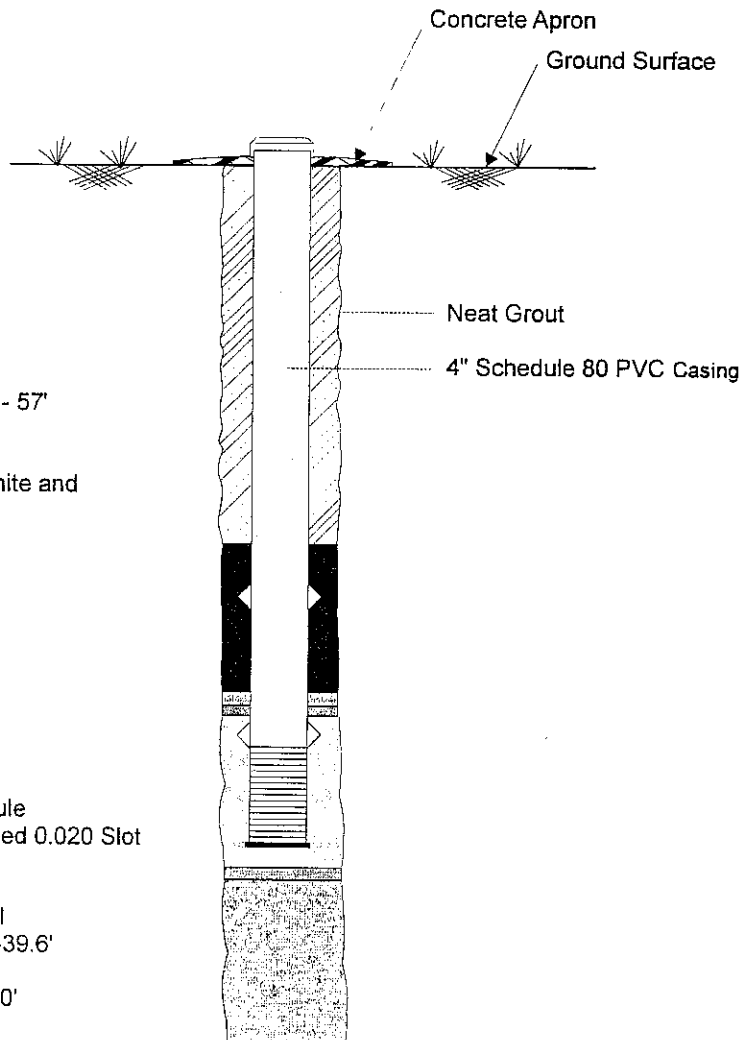
Centralizers:
 45' and 59'

Screen: 4" Stainless Steel Schedule
 40 Type 304 Wire Wrapped 0.020 Slot

Sanitary Seal:
 Portland Cement Type I/II
 with 3 - 5% Bentonite: 0 - 39.6'

End Cap: 0.44' Stainless Steel @ 70'

Total Depth: 90.5'



LEGEND

Concrete Apron
 Neat Grout
 Benseal
 Enviroplug Chips
 Sand Filter Pack
 Transition Sand
 Screen with Endcap



NOTES:

- All measurements are from below the ground surface in feet.
- Stainless steel centralizers placed above and below the screen and placed every 20 ft. along blank casing.
- Blank casing is Schedule 80 polyvinyl chloride (PVC); screen is Type 304 wire wrapped Schedule 40 stainless steel with 0.01 inch slot size.
- Top of casing is 2.5 feet above ground surface.

United States Air Force

March ARB

Monitoring Well
 Construction Diagram
 MW5

Figure

Depth of Casing:
 Blank: 0 - 73.3'
 Screen: 65' - 75'

Filter Pack/ Annular Seal:
 #2-16 Sand: 62.1' - 76.5'
 #30 Transition Sand: 61.1' - 62.1'
 and 66.5' - 67'

Enviro Plug:
 1:1 #16 Granular Bentonite and
 #2 - /16 Sand: 39.6' - 61.1'

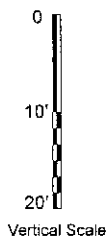
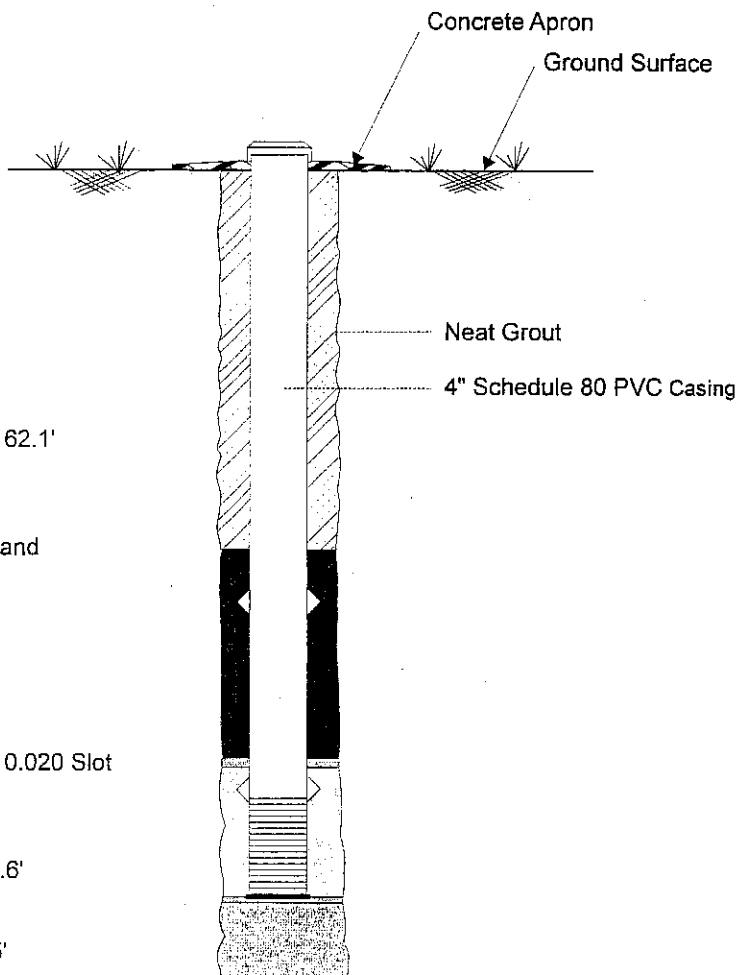
Centralizers:
 45' and 64'

Screen:
 4" Stainless Steel Schedule
 40 Type 304 Wire Wrapped 0.020 Slot

Sanitary Seal:
 Portland Cement Type I/II
 with 3 - 5% Bentonite: 0 -39.6'

End Cap:
 0.44' Stainless Steel @ 66.5'

Total Depth: 83.5"



LEGEND

Concrete Apron	
Neat Grout	
Benseal	
Sand Filter Pack	
Transition Sand	
Screen with Endcap	



NOTES:

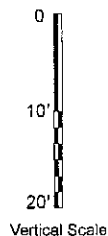
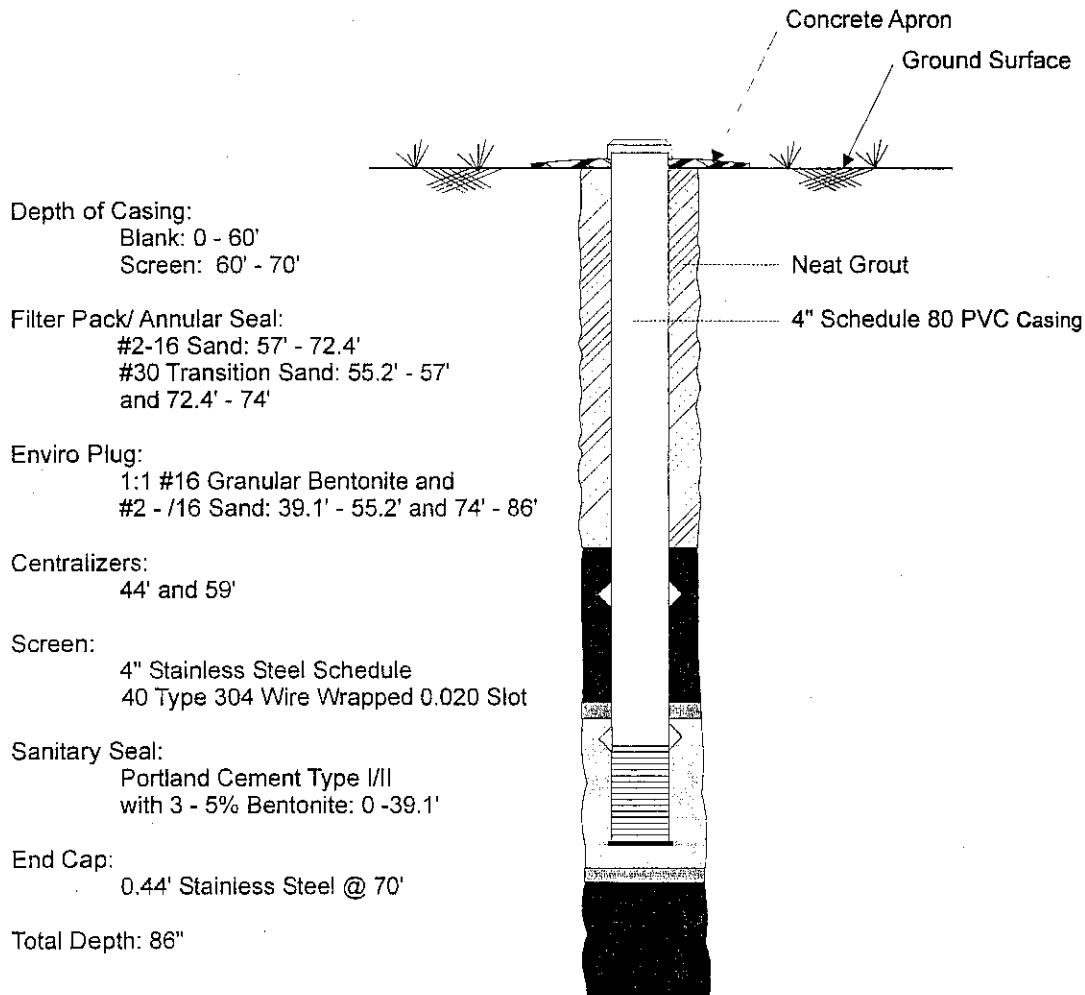
- All measurements are from below the ground surface in feet.
- Stainless steel centralizers placed above and below the screen and placed every 20 ft. along blank casing.
- Blank casing is Schedule 80 polyvinyl chloride (PVC); screen is Type 304 wire wrapped Schedule 40 stainless steel with 0.01 inch slot size.
- Top of casing is 2.5 feet above ground surface.

United States Air Force

March ARB

Monitoring Well
 Construction Diagram
 MW6

Figure



LEGEND

Concrete Apron	
Neat Grout	
Benseal	
Sand Filter Pack	
Transition Sand	
Screen with Endcap	



NOTES:

- All measurements are from below the ground surface in feet.
- Stainless steel centralizers placed above and below the screen and placed every 20 ft. along blank casing.
- Blank casing is Schedule 80 polyvinyl chloride (PVC); screen is Type 304 wire wrapped Schedule 40 stainless steel with 0.01 inch slot size.
- Top of casing is 2.5 feet above ground surface.

United States Air Force

March ARB

Monitoring Well
Construction Diagram
MW7

Figure

1780

Depth of Casing:
Blank: 0 - 50'
Screen: 30' - 50'

Enviro Plug:
1:1 #16 Granular Bentonite and
#2/16 Sand: 29'-33'

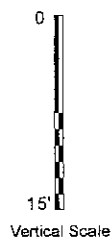
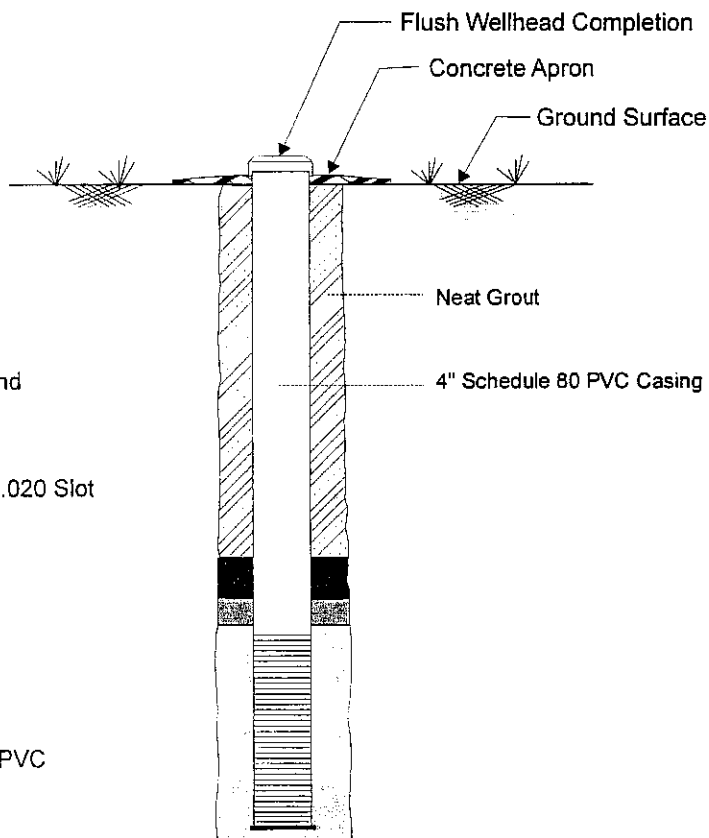
Screen: 4" Stainless Steel Schedule
40 Type 304 Wire Wrapped 0.020 Slot

Filter Pack/ Annular Seal:
#2-16 Sand: 29' - 51'
#30 Transition Sand: 34'

Sanitary Seal:
Portland Cement Type 1/11
with 3-5% Bentonite: 0-29'

Adaptor: 0.65' Box-Pin 4" Schedule 40 PVC
End Cap: 0.44' Stainless Steel @ 50'

Total Depth: 51'



LEGEND

Concrete Apron	
Neat Grout	
Benseal	
Sand Filter Pack	
Transition Sand	
Screen with Endcap	



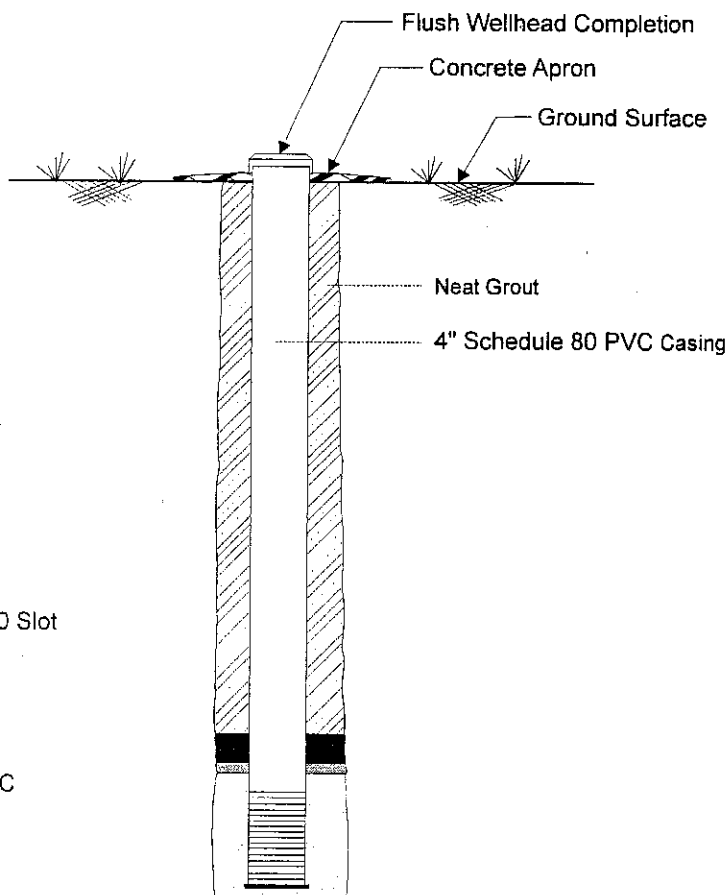
NOTES:

- All measurements are from below the ground surface in feet.
- Stainless steel centralizers placed above the screen and spaced along blank casing approximately every 50 feet.

United States Air Force

Offbase March ARB

Monitoring Well
Construction Diagram
MW8



Depth of Casing:
 Blank: 0 - 73.3'
 Screen; 63.3' - 73.3'

Filter Pack/ Annular Seal:
 #2-16 Sand: 60.9' - 74.3'
 #30 Transition Sand: 59.9' - 60.9'

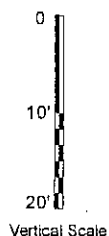
Enviro Plug:
 1:1 #16 Granular Bentonite and
 #2 - /16 Sand: 57' - 59.9'

Screen: 4" Stainless Steel Schedule
 40 Type 304 Wire Wrapped 0.020 Slot

Sanitary Seal:
 Portland Cement Type I/II
 with 3 - 5% Bentonite: 0 - 57"

Adaptor: 0.65' Box-Pin 4" Schedule 40 PVC
 End Cap: 0.44' Stainless Steel

Total Depth: 74'3"



LEGEND

Concrete Apron	
Neat Grout	
Benseal	
Sand Filter Pack	
Transition Sand	
Screen with Endcap	



NOTES:

- All measurements are from below the ground surface in feet.
- Stainless steel centralizers placed above the screen and spaced along blank casing approximately every 50 feet.

United States Air Force

Offbase March ARB

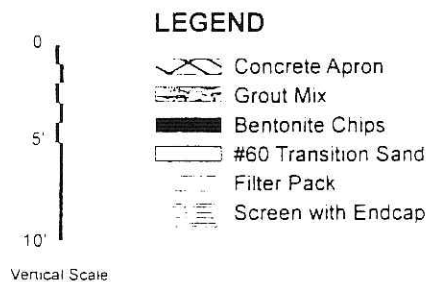
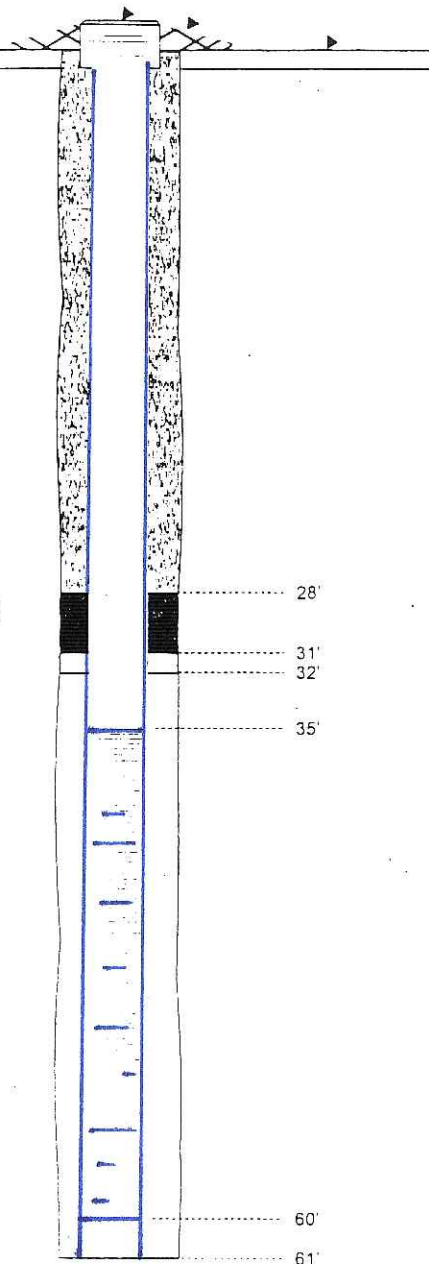
Monitoring Well
 Construction Diagram
 MW9

Flush Mounted Emco Wheaton
Traffic Rated Well Box

Concrete Apron

Pavement

- All measurements are below ground surface in feet.
- 4 inch diameter Schedule 40 PVC blank casing.
- 4 inch diameter 0.020 inch (20-slot) Schedule 40 PVC screen.
- 2/16 or equivalent sand filter pack.



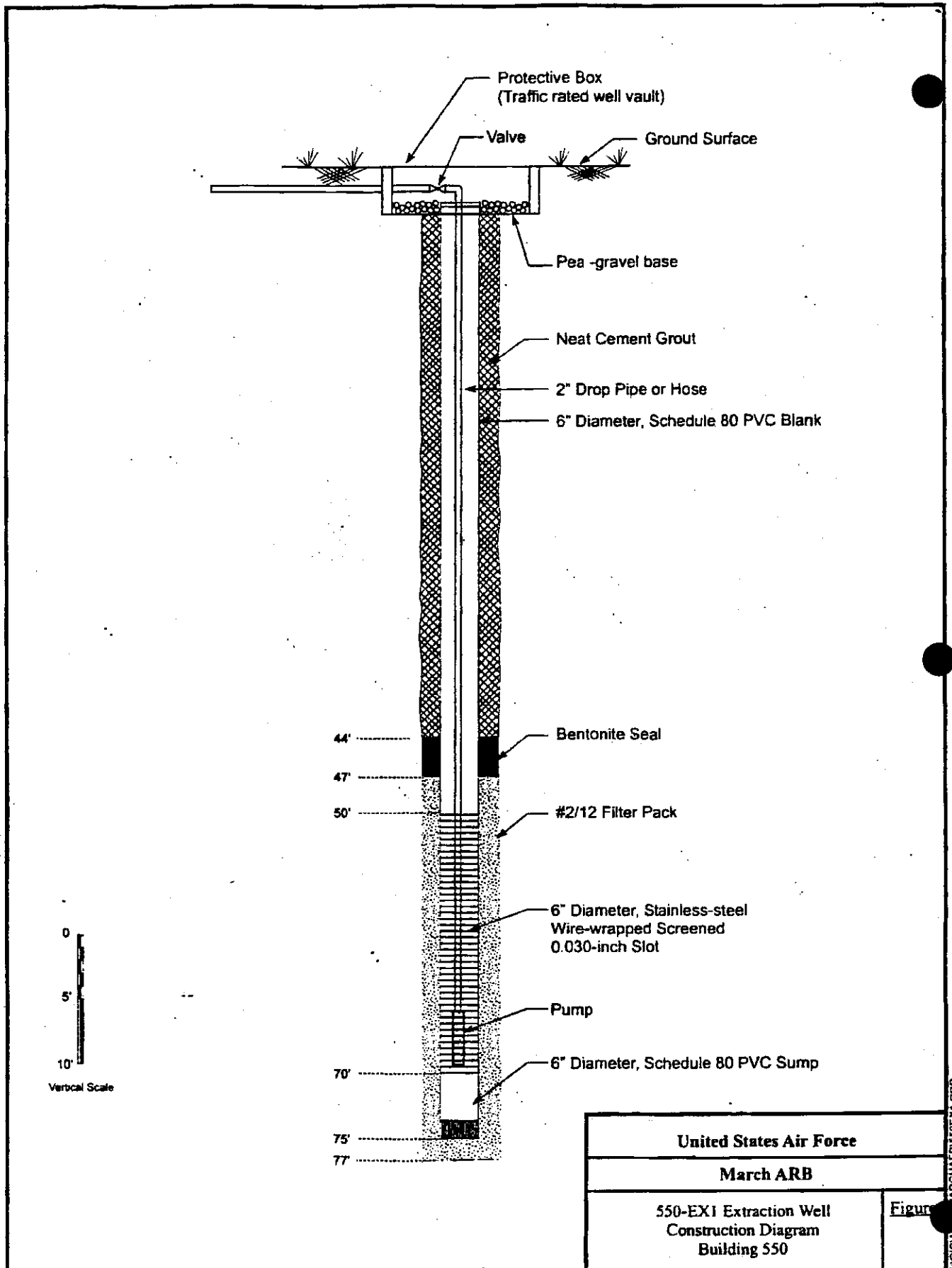
United States Air Force

March ARB

550MW10 & 550MW11
Well Construction Diagram
Building 550

Figure

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Well Construction Information
Building 550

Well I.D.	Date Installed	Well Elevation TOC (feet)	Screen Elevation TOS (feet)	Screen Elevation BOS (feet)	Screen Length (feet)	Length of Sediment Trap (feet)	Depth of Well (feet)	Borehole Diameter (inches)	Casing Diameter (inches) & material	Screen Slot Size (inches) & material	Drilling Method	FilterPack Grain Size	Northing Coordinate (y)	Easting Coordinate (x)
550MW1	11/27/1996	1536.82	1541.82	1526.82	15.00	0.00	60.00	10	4 PVC	.010 PVC	HSA	2/16 Lonestar sand	2274807.64	6257419.60
550MW2	11/26/1996	1536.79	1541.79	1526.79	15.00	0.00	55.00	10	4 PVC	.010 PVC	HSA	2/16 Lonestar sand	2274741.17	6257412.89
550MW3	11/25/1996	1537.08	1537.08	1527.08	10.00	0.00	63.00	10	4 PVC	.010 PVC	HSA	2/16 Lonestar sand	2274742.76	6257338.61
550MW4	11/6/1998	1537.40	1539.40	1529.40	10.00	0.00	90.00	8	4 PVC	.020 SS	SONIC	2/16 Lonestar sand	2274807.76	6257411.38
550MW5	11/16/1998	1536.21	1538.21	1528.21	10.00	0.00	70.00	8	4 PVC	.020 SS	SONIC	2/16 Lonestar sand	2274707.68	6257379.38
550MW6	11/19/1998	1537.49	1539.49	1529.49	10.00	0.00	75.00	8	4 PVC	.020 SS	SONIC	2/16 Lonestar sand	2274863.85	6257445.80
550MW7	11/22/1998	1536.57	1538.57	1528.57	10.00	0.00	70.00	8	4 PVC	.020 SS	SONIC	2/16 Lonestar sand	2274801.17	6257298.43
550MW8	3/8/1999	1534.40	1539.40	1524.40	15.00	0.00	50.00	10	4 PVC	.020 SS	HSA	2/16 Lonestar sand	2274616.11	6257342.94
550MW9	3/9/1999	1537.89	1537.89	1527.89	10.00	0.00	70.00	10	4 PVC	.020 SS	HSA	2/16 Lonestar sand	2274958.85	6257311.11
550MW10	10/10/2001	1537.62	1552.62	1527.62	25.00	0.00	60.00	10	4 PVC	.020 SS	HSA	2/16 Lonestar sand	2274784.79	6257396.62
550MW11	10/11/2001	1534.63	1549.63	1524.63	25.00	0.00	60.00	10	4 PVC	.020 SS	HSA	2/16 Lonestar sand	2274637.05	6257389.45
550EX01	10/15/2001	1538.57	1549.57	1529.57	20.00	5.00	77.00	14	6 PVC	0.030 SS	HSA	2/12 Lonestar sand	2274793.97	6257418.58

TABLE 2

**BUILDING 550 NEW WELL CONSTRUCTION DATA
FORMER MARCH AFB, CALIFORNIA
(Page 1 of 2)**

Well ID	Date Installed	Hydro. Unit	Well Type	TOC Elevation (feet msl)	Depth to Water (feet)	TOS Depth (feet-TOC)	TOS Elevation (feet msl)	BOS (feet-TOC)	Depth (feet-TOC)	BOS Elevation (feet msl)	Screen Length (feet)
550MW12	1/30/2003	A	WMW	1537.17	30	37.0	1488.5	47.0	47.0	1478.5	10
550MW13	1/30/2003	A	WMW	1535.92	31	41.0	1478.1	56.0	56.0	1463.1	15
550MW14	5/28/2003	A	WMW	1531.35	41	58.0	1463.4	68.0	68.0	1453.4	10

BOS - bottom of screen
HSA - Hollow Stem Auger
msl - mean sea level
TBD - to be determined

TOC - Top of Casing
TOS - top of screen
WMW - Water Monitoring Well

TABLE 2

**BUILDING 550 NEW WELL CONSTRUCTION DATA
FORMER MARCH AFB, CALIFORNIA
(Page 2 of 2)**

Well ID	Well Depth (feet)	Borehole Diameter (inches)	Drilling Method	Casing Diameter (inches) & Material	Screen Slot Size (inches) & Material	Filter Pack Grain Size	Northing	Easting
550MW12	47	10	HSA	4 PVC	0.010 PVC	2/12 sand	2274592.6967	6257142.6382
550MW13	56	10	HSA	4 PVC	0.010 PVC	2/12 sand	2274423.2907	6257165.2042
550MW14	50	10	HSA	4 PVC	0.010 PVC	2/12 sand	2274220.8477	6257330.6076

BOS - bottom of screen

HSA - Hollow Stem Auger

msl - mean sea level

TBD - to be determined

TOC - Top of Casing

TOS - top of screen

WMW - Water Monitoring Well



Cone Penetration Testing Procedure (CPT)

Gregg In Situ, Inc. carries out all Cone Penetration Tests (CPT) using an integrated electronic cone system, *Figure CPT*. The soundings were conducted using a 20 ton capacity cone with a tip area of 15 cm^2 and a friction sleeve area of 225 cm^2 . The cone is designed with an equal end area friction sleeve and a tip end area ratio of 0.85.

The cone takes measurements of cone bearing (q_c), sleeve friction (f_s) and dynamic pore water pressure (u_2) at 5-cm intervals during penetration to provide a nearly continuous hydrogeologic log. CPT data reduction and interpretation is performed in real time facilitating on-site decision making. The above mentioned parameters are stored on disk for further analysis and reference. All CPT soundings are performed in accordance with revised (2002) ASTM standards (D 5778-95).

The cone also contains a porous filter element located directly behind the cone tip (u_2), *Figure CPT*. It consists of porous plastic and is 5.0mm thick. The filter element is used to obtain dynamic pore pressure as the cone is advanced as well as Pore Pressure Dissipation Tests (PPDT's) during appropriate pauses in penetration. It should be noted that prior to penetration, the element is fully saturated with silicon oil under vacuum pressure to ensure accurate and fast dissipation.

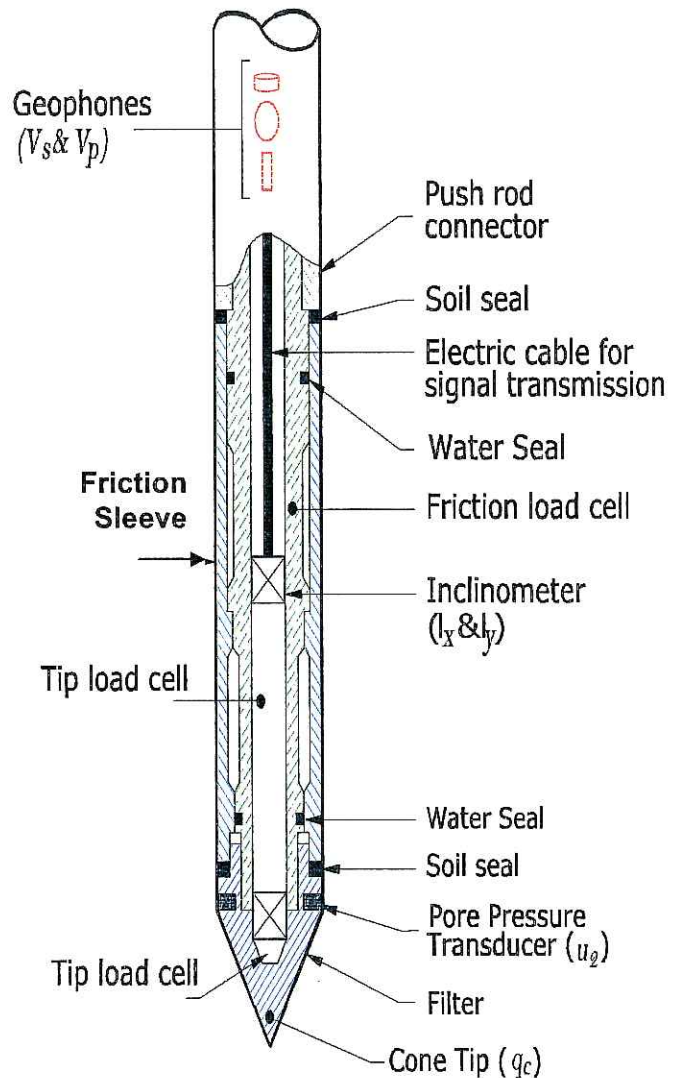


Figure CPT

When the soundings are complete, the test holes are grouted using a Gregg In Situ support rig. The grouting procedure consists of pushing a hollow CPT rod with a "knock out" plug to the termination depth of the test hole. Grout is then pumped under pressure as the tremie pipe is pulled from the hole. Disruption or further contamination to the site is therefore minimized.



Cone Penetration Test Data & Interpretation

Soil behavior type and stratigraphic interpretation is based on relationships between cone bearing (q_c), sleeve friction (f_s), and pore water pressure (u_2). The friction ratio (R_f) is a calculated parameter defined by $100f_s/q_c$ and is used to infer soil behavior type. Generally:

Cohesive soils (clays)

- High friction ratio (R_f) due to small cone bearing (q_c)
- Generate large excess pore water pressures (u_2)

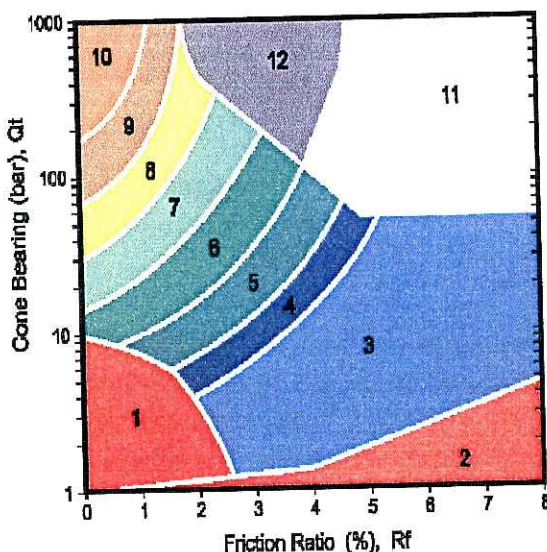
Cohesionless soils (sands)

- Low friction ratio (R_f) due to large cone bearing (q_c)
- Generate very little excess pore water pressures (u_2)

A complete set of baseline readings are taken prior to and at the completion of each sounding to determine temperature shifts and any zero load offsets. Corrections for temperature shifts and zero load offsets can be extremely important, especially when the recorded loads are relatively small. In sandy soils, however, these corrections are generally negligible.

The cone penetration test data collected from your site is presented in graphical form in Appendix CPT. The data includes CPT logs of measured soil parameters, computer calculations of interpreted soil behavior types (SBT), and additional geotechnical parameters. A summary of locations and depths is available in Table 1. Note that all penetration depths referenced in the data are with respect to the existing ground surface.

Soil interpretation for this project was conducted using recent correlations developed by Robertson et al, 1990, *Figure SBT*. Note that it is not always possible to clearly identify a soil type based solely on q_c , f_s , and u_2 . In these situations, experience, judgment, and an assessment of the pore pressure dissipation data should be used to infer the soil behavior type.



ZONE	Q _t /N	SBT
1	2	Sensitive, fine grained
2	1	Organic materials
3	1	Clay
4	1.5	Silty clay to clay
5	2	Clayey silt to silty clay
6	2.5	Sandy silt to clayey silt
7	3	Silty sand to sandy silt
8	4	Sand to silty sand
9	5	Sand
10	6	Gravelly sand to sand
11	1	Very stiff fine grained*
12	2	Sand to clayey sand*

*over consolidated or cemented

Figure SBT



Pore Pressure Dissipation Tests (PPDT)

Pore Pressure Dissipation Tests (PPDT's) conducted at various intervals measured hydrostatic water pressures and determined the approximate depth of the ground water table. A PPDT is conducted when the cone is halted at specific intervals determined by the field representative. The variation of the penetration pore pressure (u) with time is measured behind the tip of the cone and recorded by a computer system.

Pore pressure dissipation data can be interpreted to provide estimates of:

- Equilibrium piezometric pressure
- Phreatic Surface
- In situ horizontal coefficient of consolidation (c_h)
- In situ horizontal coefficient of permeability (k_h)

In order to correctly interpret the equilibrium piezometric pressure and/or the phreatic surface, the pore pressure must be monitored until such time as there is no variation in pore pressure with time, *Figure PPDT*. This time is commonly referred to as t_{100} , the point at which 100% of the excess pore pressure has dissipated.

A complete reference on pore pressure dissipation tests is presented by Robertson et al. 1991.

A summary of the pore pressure dissipation tests is summarized in Table 1. Pore pressure dissipation data is presented in graphical form in Appendix PPDT.

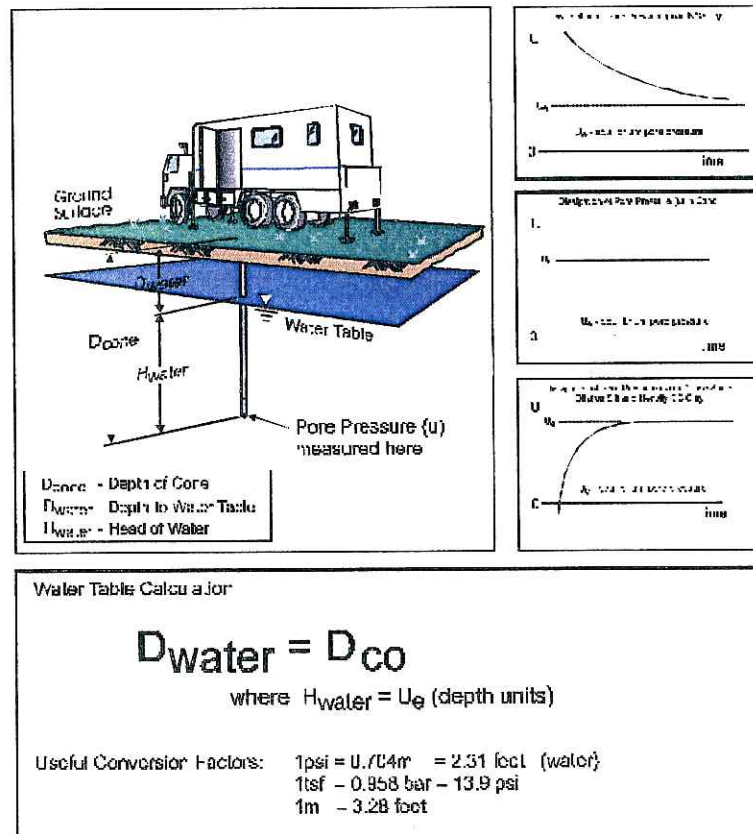


Figure PPDT



Bibliography

Campanella, R.G. and I. Weemees, "Development and Use of An Electrical Resistivity Cone for Groundwater Contamination Studies", Canadian Geotechnical Journal, Vol. 27 No. 5, 1990 pp. 557-567.

Daniel, C.R., J.A. Howie and A. Sy, "A Method for Correlating Large Penetration Test (LPT) to Standard Penetration Test (SPT) Blow Counts", 55th Canadian Geotechnical Conference, Niagara Falls, Ontario, Proceedings, 2002.

DeGroot, D.J. and A.J. Lutenecker, "Reliability of Soil Gas Sampling and Characterization Techniques", International Site Characterization Conference - Atlanta, 1998.

Greig, J.W., R.G. Campanella and P.K. Robertson, "Comparison of Field Vane Results With Other In-Situ Test Results", International Symposium, on Laboratory and Field Vane Shear Strength Testing, ASTM, Tampa, FL, Proceedings, 1987.

Kurfurst, P.J. and D.J. Woeller, "Electric cone Penetrometer - Development and Field Results From the Canadian Arctic", Penetration Testing 1988 ISOPT, Orlando, Volume 2 pp 823-830.

Marchetti S., P. Monaco, G. Totani, M. Calabrese, "The Flat Dilatometer Test (DMT) in Soil Investigations", Report of the ISSMGE Technical Committee, IN SITU 2001 Intl. Conf. On in Situ Measurement of soil Properties, Bali, Indonesia.

Mayne, P.W., "NHI (2002) Manual on Subsurface Investigations: Geotechnical Site Characterization", available through www.ce.gatech.edu/~geosys/Faculty/Mayne/papers/index.html, Section 5.3, pp. 107-112.

Robertson, P.K., R.G. Campanella, D. Gillespie and A. Rice, "Seismic CPT to Measure In-Situ Shear Wave Velocity", Journal of Geotechnical Engineering ASCE, Vol. 112, No. 8, 1986 pp. 791-803.

Robertson, P.K., T. Lunne and J.J.M. Powell, "Geo-Environmental Application of Penetration Testing", Geotechnical Site Characterization, Robertson & Mayne (editors), 1998 Balkema, Rotterdam, ISBN 90 5410 939 4 pp 35-47.

Roberston, P.K., "Soil Classification using the Cone Penetration Test", Canadian Geotechnical Journal, Vol. 27, 1990 pp. 151-158.

Woeller, D.J., P.K. Robertson, T.J. Boyd and Dave Thomas, "Detection of Polyaromatic Hydrocarbon Contaminants Using the UVIF-CPT", 53rd Canadian Geotechnical Conference Montreal, QC October pp. 733-739, 2000.

Zemo, D.A., T.A. Delfino, J.D. Gallinatti, V.A. Baker and L.R. Hilpert, "Field Comparison of Analytical Results from Discrete-Depth Groundwater Samplers" BAT EnviroProbe and QED HydroPunch, Sixth national Outdoor Action Conference, Las Vegas, Nevada Proceedings, 1992, pp 299-312.

Copies of ASTM Standards are available through www.astm.org

Ultra Violet Induced Fluorescence (UVIFCPTu)

Gregg In Situ, Inc. conducts Ultra Violet Induced Fluorescence (UVIF) Cone Penetration Tests using a UVIF module that is located behind the standard piezocone, *Figure UVIF*. The ultra violet induced fluorescence cone works on the principle that polyaromatic hydrocarbons (PAH's), mixed with soil and groundwater, fluoresce when irradiated by ultra violet light. Therefore, by measuring the UVIF intensity of the soil and groundwater the lateral and vertical extent of polyaromatic hydrocarbon contamination in the ground can be determined.

The UVIF module uses principles of fluorescence spectrometry by irradiating the soil with ultra violet light. The hydrocarbon molecules absorb the UV light energy during radiation and immediately re-emit the light at a longer wavelength. This re-emission is termed fluorescence. The difference between the excitation (250 nm) and emission (275-550 nm) wavelengths is called the Stokes shift. Specific hydrocarbon compounds can be identified by the magnitude of their Stokes shift, *Figure EWL*.

In general, as the number of aromatic rings increase the fluorescent response shifts toward longer wavelengths. Therefore, lighter compounds tend to fluoresce at shorter wavelengths and heavier compounds fluoresce at longer wavelengths.

The UVIF module contains a fiber optic cable that captures the emitted radiation and sends it to an amplifier at the surface so the intensity can be recorded. Therefore, the soil parameters are recorded along with the UVIF intensity in real time, *Figure Output*.

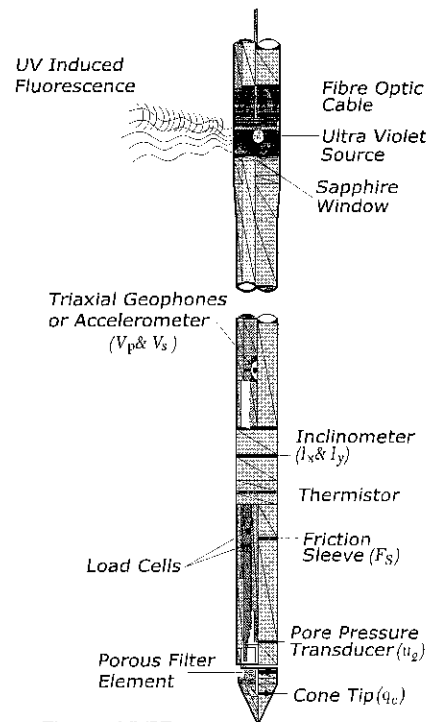


Figure UVIF

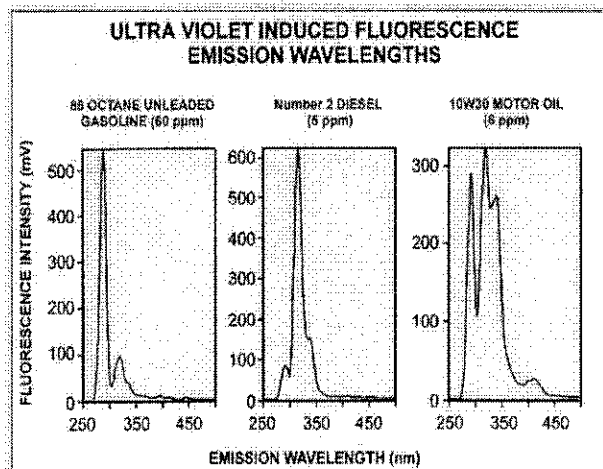


Figure EWL (After Fontana, 1994)

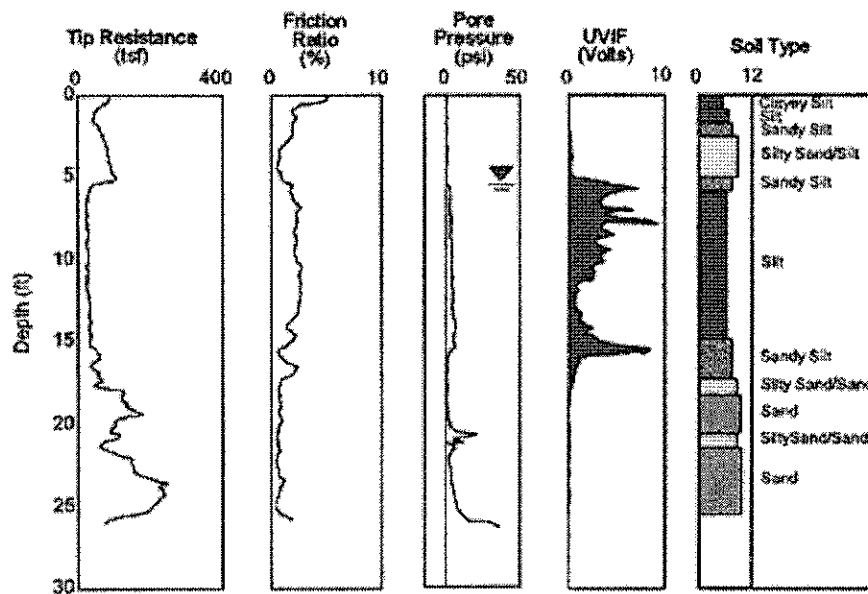


Figure Output

For a detailed reference on UVIF cone testing, refer to Woeller et. al., 2000.



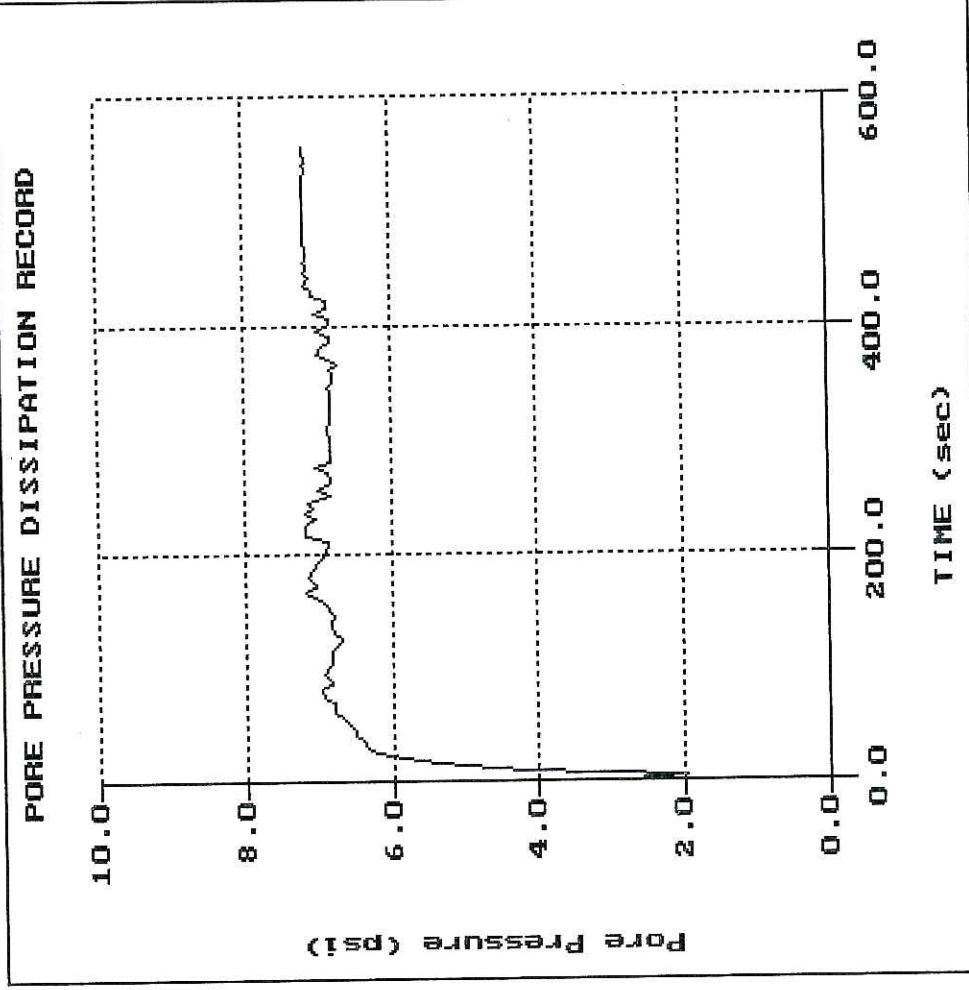
2726 Walnut Avenue · Signal Hill · California · 90755 · Phone: (562) 427-6899 · Fax: (562) 427-3314
 Web Site: www.greggdrilling.com Email: info@greggdrilling.com
 Additional locations in: Charleston · Houston · Palo Alto · Salt Lake City · San Francisco · Vancouver

EARTH TECH

Site: MARCH AFB
Location: CPT-01

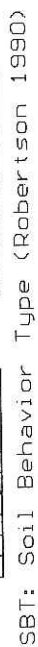
Engineer: B. MUIR
Date: 03:11:05 07:48

File: 060C01.PPC
Depth (m): 11.50
Depth (ft): 37.73
Duration: 555.0s
U-min: 1.93 5.0s
U-max: 7.16 550.0s





Engineer: B. MUIR
Date: 03:11:05 08:35



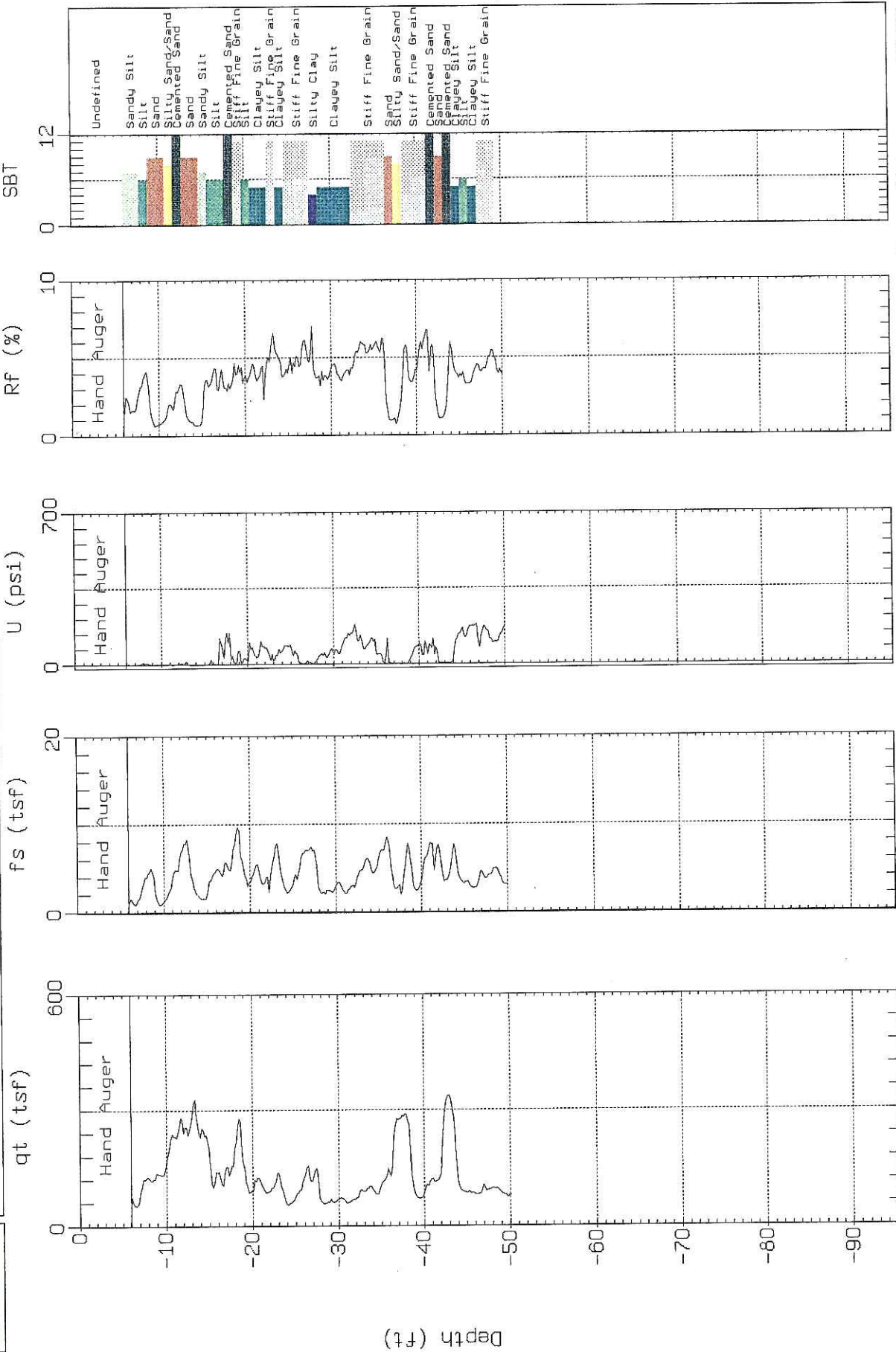
Max. Depth: 95.14 (ft)
Depth Inc.: 0.164 (ft)



EARTH TECH

Site: MARCH AFB
Location: CPT-01

Engineer: B. MUIR
Date: 03:11:05 07:48



SBT: Soil Behavior Type (Robertson 1990)

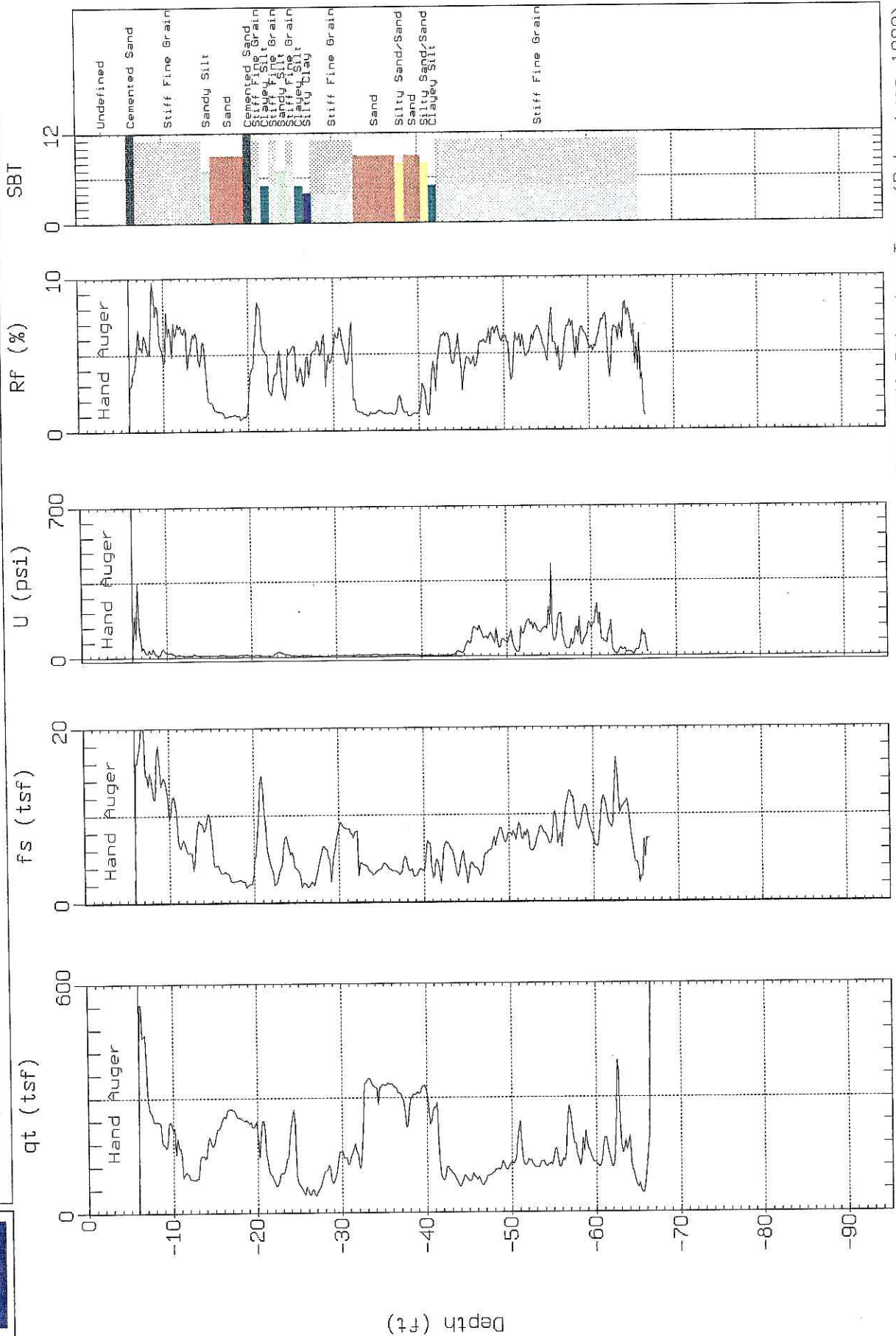
Max. Depth: 50.03 (ft)
Depth Inc.: 0.164 (ft)



EARTH TECH

Site: MARCH AFB
Location: CPT-03

Engineer: B. MUIR
Date: 03:11:05 09:50



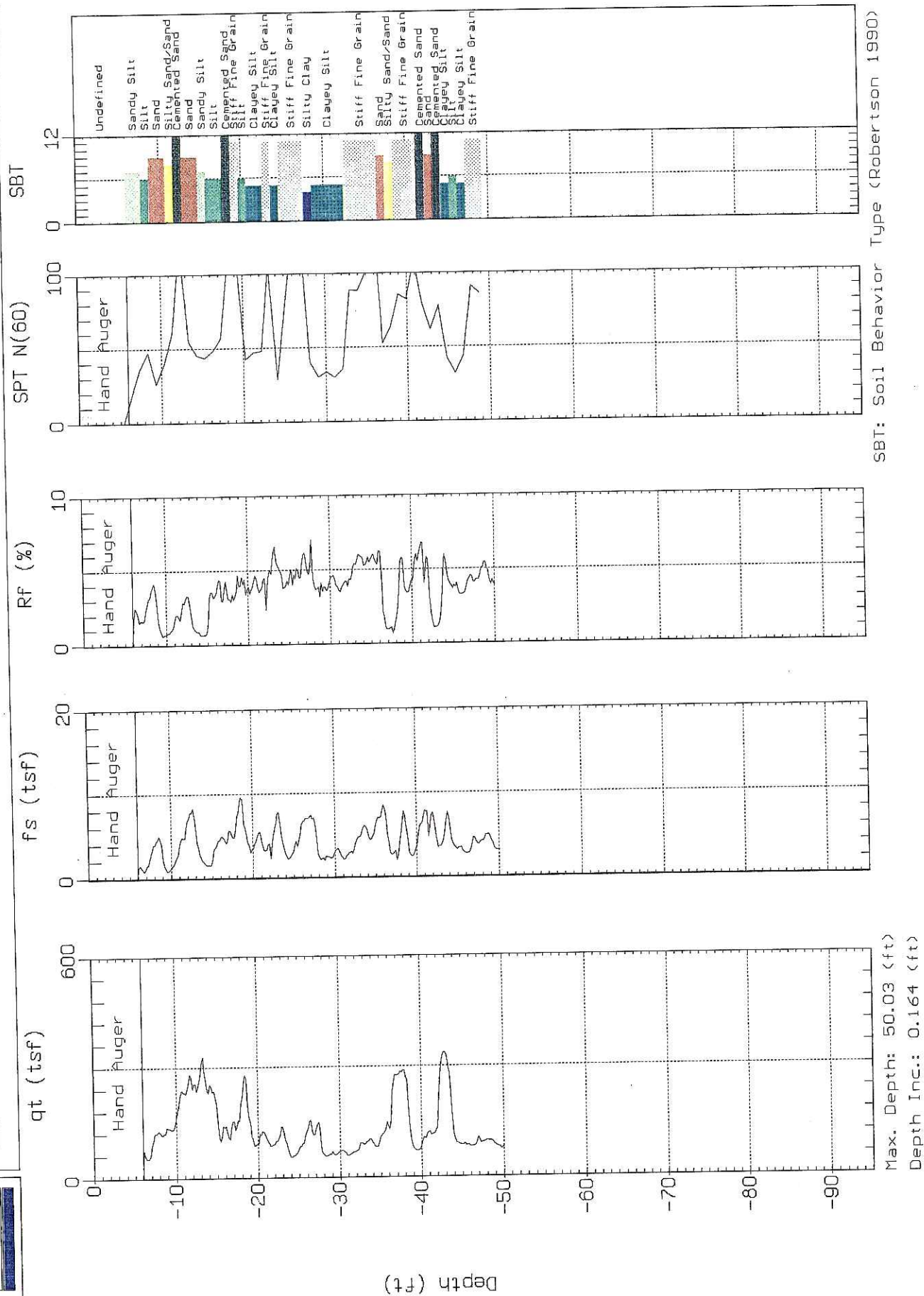
Max. Depth: 66.60 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)



Site: MARCH AFB
Location: CPT-01

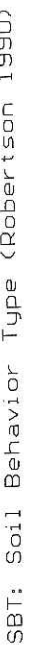
Engineer: B. MUIR
Date: 03:11:05 07:48



SBT: Soil Behavior Type (Robertson 1990)



Engineer: B. MUIR
Date: 03:11:05 08:35



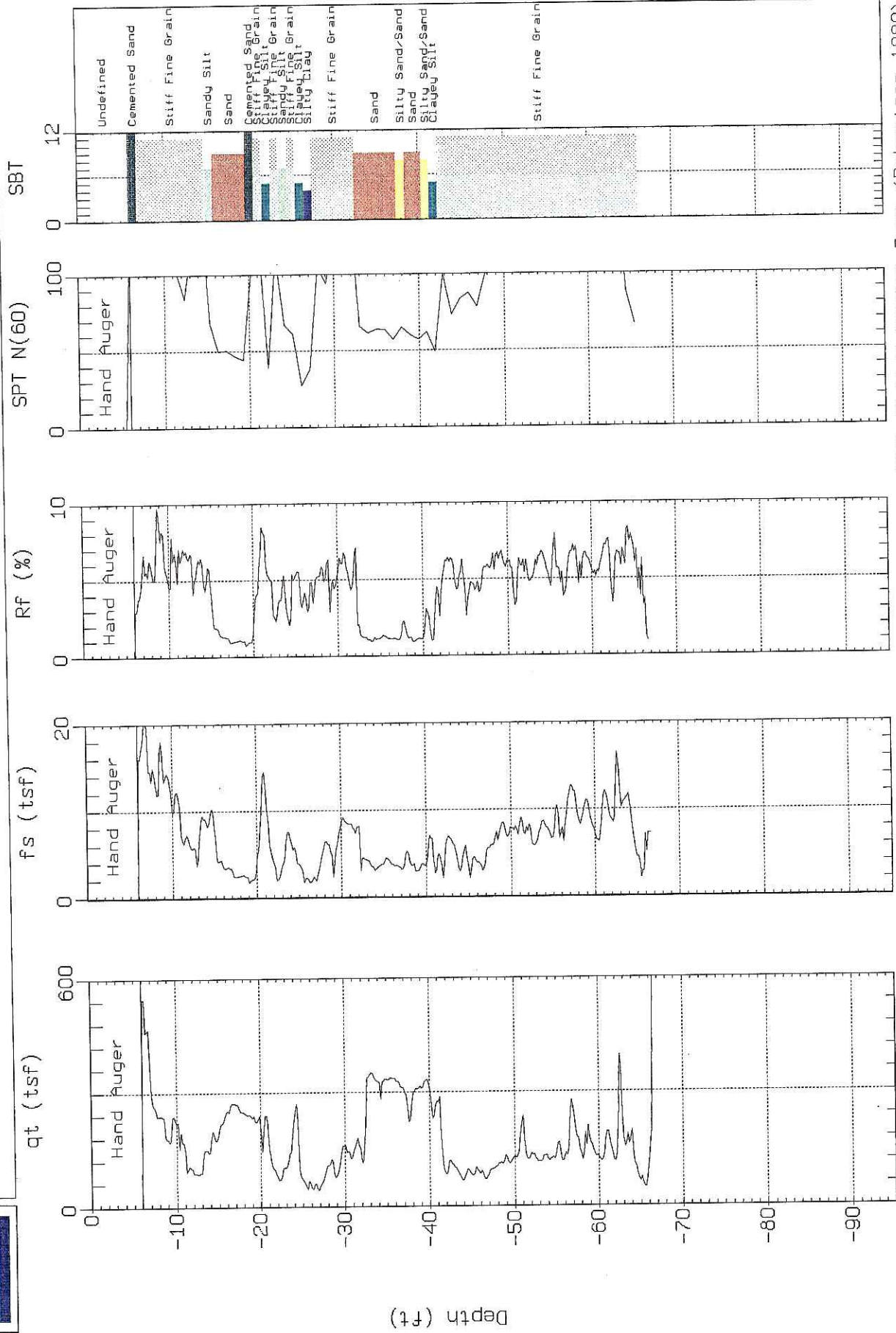
Max. Depth: 95.14 (ft)
Depth Inc.: 0.164 (ft)



EARTH TECH

Site: MARCH AFB
Location: CPT-03

Engineer: B. MUIR
Date: 03:11:05 09:50



SBT: Soil Behavior Type (Robertson 1990)

Max. Depth: 66.60 (ft)
Depth Inc.: 0.164 (ft)

APPENDIX C

ON-SITE LABORATORY STANDARD OPERATING PROCEDURES EPA METHODS 8260B

ANALYTICAL METHOD
8260B SOP

**H&P MOBILE GEOCHEMISTRY
STANDARD OPERATING PROCEDURES (SOPs)**

EPA Method 8260B

Revision 13
November 2004

1.0 Scope and Applications

This SOP has been prepared for H&P Mobile Geochemistry to help ensure consistent analytical protocol and applies to the performance of the EPA Method 8260B. This method is applicable to soil, water and soil vapor samples. The scope of topics discussed in this SOP includes the following:

- * Method Summary
- * Health and Safety Warnings
- * Cautions
- * Interferences
- * Personnel Qualifications
- * Instruments and Materials
- * Method Calibration
- * Sample Collection
- * Handling & Preservation
- * Sample Preparation
- * Troubleshooting
- * Data Acquisition, Calculation and Data Reduction
- * Computer Hardware and Software
- * Data Management and Records Management
- * QA/QC Requirements
- * References

The following topics are included as part of this SOP by reference as follows:

- * References and Definitions (Appendix A of QSM)
- * Waste Management and Pollution Prevention (Section 5.0 of QSM)
- * Data Assessment (Section 8.2 of QSM)
- * Corrective Action and Contingencies for out-of-control data (Section 8.0 of QSM)

2.0 Summary of Method

H&P Mobile Geochemistry uses EPA Method 8260B to identify sixty-four (64) volatile organic compounds. Samples are introduced into the chromatograph by Purge and Trap EPA Method 5030 or 5035, either as a direct purge of soil or water or as an extraction followed by purge and trap of an

aliquot of the extract. Soil vapor samples are treated in an identical manner to that of water samples with the exception that the internal standards (I.S.) and surrogates are added to water in the purge apparatus prior to the introduction of the vapor sample. The analysis is performed on a gas chromatograph (GC) with a quadrupole mass spectrometer (MS).

The volatile organic compounds identified are as follows:

Dichlorodifluoromethane
Chloromethane
Vinyl Chloride
Bromomethane
Chloroethane
Trichlorofluoromethane
1,1-Dichloroethene
Methylene Chloride
Methyl t-butyl ether
trans-1,2-Dichloroethene
1,1-Dichloroethane
2,2-Dichloropropane
cis-1,2-Dichloroethene
Chloroform
Bromochloromethane
1,1,1-Trichloroethane
1,1-Dichloropropene
Carbon Tetrachloride
1,2-Dichloroethane
Benzene
Trichloroethene
1,2-Dichloropropane
Bromodichloromethane
Dibromomethane
trans-1,3-Dichloropropene
Toluene
cis-1,3-Dichloropropene
1,1,2-Trichloroethane
1,2-Dibromoethane
1,3-Dichloropropane
Tetrachloroethene
Dibromochloromethane
Chlorobenzene
Ethylbenzene
1,1,1,2-Tetrachloroethane
m,p-Xylene
o-Xylene
Styrene
Bromoform
Isopropylbenzene
1,1,2,2-Tetrachloroethane

1,2,3-Trichloropropane
n-propylbenzene
Bromobenzene
1,3,5-Trimethylbenzene
2-Chlorotoluene
4-Chlorotoluene
tert-Butylbenzene
1,2,4-Trimethylbenzene
sec-Butylbenzene
p-Isopropyltoluene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
n-Butylbenzene
1,2-Dichlorobenzene
1-2-Dibromo-3-chloropropane
1,2,4-Trichlorobenzene
Hexachlorobutadiene
Naphthalene
1,2,3-Trichlorobenzene
Diisopropyl ether
Ethyl t-butyl ether
2-methoxy-2-methylbutane
t-Butanol

3.0 Health and Safety Warnings

H&P Mobile Geochemistry employs conservative safety practices at all times. Eye protection is to be worn by all laboratory operators while sample preparation, extraction and analysis are taking place. The laboratory operator is not to enter the exclusion zone (nor any other areas designated as exclusive by the field safety officer) at any time. Sample handling will be carried out beneath the "hood" when possible. Smoking is not permitted in the van and eating is not permitted in the analysis area of the van. Fire extinguishers, first aid kits and Material Safety Data Sheets are located in each van. The laboratory equipment may include high-pressure hydrogen which is a fire and explosion hazard.

4.0 Cautions

The analyst is cautioned that the equipment uses high-pressure gases which, while not flammable nor explosive, are suffocating in large quantities. The lab may also contain high pressure hydrogen for other analyses and that there is both a fire and explosion hazard in the event of a leaking system. The analyst should be aware of any potential source of leaking H₂ gas and should inspect all plumbing from hydrogen cylinders to the instruments on a daily basis.

5.0 Interferences

When analyzing for volatile organics, samples can be contaminated by diffusion of volatile organics through the sample container septum during shipment or storage. A trip blank prepared from organic-free reagent water and carried through sampling and subsequent storage and handling can serve as a check on such contamination.

Contamination carryover can occur whenever high-concentration and low-concentration samples are analyzed in sequence. To reduce the potential carryover, the sample syringe or purging device is rinsed out between samples with an appropriate solvent. Whenever an unusually concentrated sample is encountered, it should be followed by injection of a solvent blank to check for cross contamination

6.0 Personnel Qualifications

This method is to be performed by a trained analyst in gas chromatographic/mass spectrometric methods. A bachelor's degree in science or equivalent training is the minimum requirement for performance of this method. In addition, a mobile lab analyst performing this method without on-site supervision must have a minimum of 3 months of GC/MS experience with this method or equivalent.

7.0 Instruments and Materials

The following subsections discuss the instrumentation and materials needed for this method.

7.1 Instruments

H&P Mobile Geochemistry uses several GC/MS systems for EPA Method 8260B analysis. The labs use HP GCs coupled to a Mass Selective Detector (MSD). The purge and trap is a Tekmar 3000 with a 2016 autosampler or a Tekmar Solatek 72 autosampler with 72 sample capacity. H&P Mobile Geochemistry has had the most success using HP-624 columns of 60m X 0.32 X 1.8u film thickness and uses these columns in all systems. The carrier gas He is UHP purity. The following instrument conditions are typical:

GC	
Split mode	20:1
Injector temp.	200 degrees C
Interface temp.	230 degrees C
Column:	60m x 0.32mm x 1.8u HP-624
Flow:	1.1 mL/min He
Initial temp.	40 degrees C 4 minute

Ramp 20 degrees/min
Final temp 230 degrees

MS
SCAN mode 41-300 amu, 2.5 scans/sec
Source temp 230 degrees
Quad temp 150 degrees
Multiplier +200 relative

Detailed descriptions of the analytical method parameters are to be found in the initial demonstration of proficiency data package which is kept as part of H&P Mobile Geochemistry Lab initial lab certification.

The following SOP is written for analysts using either a Tekmar 2016 Autosampler or a Tekmar Solatek Autosampler. The 2016 AS requires default sample amounts of 2 g soil, 10 mL water and 10 mL vapor. Water containing 50 ng of I.S. (2.5 uL of 20 ug/mL I.S.) and 50 ng of surrogate solution (2.5 uL of 20 ug/mL surrogate solution) is manually transferred from a 10 mL syringe to the purge tube.

The Solatek AS has default amounts of 5 g soil, 20 mL water and 20 mL vapor. The Solatek AS automatically adds 50 ng I.S. (5 uL of 10 ug/mL I.S.) and 50 ng surrogate solution (5 uL of 10 ug/mL surrogate solution) to each sample.

Soil samples are weighed on toploading balances such as the Acculab 333 digital balance. For EPA Method 5035 a sample core roughly equivalent to 5 grams is taken using a coring device or a plastic syringe. Water samples are measured in gas tight syringes from 20 mL down to 10 uL. Purge and Trap grade methanol is used as the solvent for soil extractions. Ten uL and 25 uL syringes are used during dilution preparations. Sample preparation is performed with ventilation directed to the outside of the van. Soil vapor samples are taken in gas-tight 5, 10 and 25 mL syringes and immediately transferred to the autosampler purge apparatus

HP Chemstation software version G1701BA with Enviroquant software running on Windows NT/Pentium personal computers are used for data acquisition and instrument control. Chromatograms and quantitation reports are printed out on HP Laserjet printers.

The above-mentioned equipment requires 110 VAC as a power source to operate.

Sources of further information can be found in the Hewlett-Packard GC/MS and the Tekmar Purge and Trap hardware and software manuals, which are kept with each instrument. Each instrument also comes with HP maintenance information on CD, which can be viewed on the computer.

7.2 Reagents and Standards

Purge and Trap grade methanol is used for all extractions and dilutions of standards. Primary standards for analytes, surrogates and internal standards are normally purchased from commercial vendors and are diluted for use. All purchased standards are shipped with certification attesting to their purity and authenticity. Each mobile lab and the fixed-based lab have notebooks to record standards. Refer to H&P Mobile Geochemistry' SOP manual or the individual notebook for nomenclature of standards.

All standards should be stored in the standards refrigerators located within the vans and stored separately from samples.

7.2.1 Standard Preparation

If available, primary standards of 2000 ug/mL should be purchased. Normally a solution is diluted to a convenient volume, such as 10 to 1. To prepare a stock standard from a primary solution, place approximately 8 mL Purge & Trap grade methanol in a 10 mL ground glass stoppered volumetric flask. Inject 1 mL of the 2000 ug/mL primary standard into the methanol using a syringe. Fill the flask to volume, stopper the flask, and mix by inverting three times. Calculate the concentration of the stock standard in ug/mL by dividing the primary concentration (2000 ug/mL) by 10, resulting in 200 ug/mL.

Label the storage vial with the proper lab ID, concentration in ug/mL, the expiration date and the initials of the chemist. Transfer the stock standard to the pre-labeled vial and store at 4 degrees C. Log the standard into the laboratory system.

To prepare a working secondary standard (suitable for creating an initial calibration curve or performing continuing calibration checks) from a stock standard solution, place approximately 8 mL Purge & Trap grade methanol in a 10 mL ground glass stoppered volumetric flask. Inject 1 mL of the 200 ug/mL stock standard into the methanol using a syringe. Fill the flask to volume, stopper the flask, and mix by inverting three times. Calculate the concentration of the secondary standard in ug/mL by dividing the stock concentration (200 ug/mL) by

10, resulting in 20 ug/mL. Label properly and transfer to a storage vial.

To prepare a low secondary standard (suitable for creating an initial calibration curve) from a stock standard solution, place approximately 8 mL Purge & Trap grade methanol in a 10 mL ground glass stoppered volumetric flask. Inject 100 uL of the 200 ug/mL stock standard into the methanol using a syringe. Fill the flask to volume, stopper the flask, and mix by inverting three times. Calculate the concentration of the secondary standard in ug/mL by dividing the stock concentration (200 ug/mL) by 100, resulting in 2 ug/mL. Label properly and transfer to a storage vial.

7.2.2 Standard Expiration

Standards for VOC analysis will be prepared and given expiration dates of no longer than those indicated below. Care must be taken that these dates do not exceed the manufacturer's date of expiration on the primary standard.

Stock Standards

Internal Standards and surrogates	- 6 months
Non gas VOCs	- 6 months
Gaseous VOCs	- 1 month

Secondary Standards

Internal Standards and surrogates	- 3 months
All other standards	- 1 month

Volatile, non-gas standards such as 1,1 DCE have been found to decrease in the EPA 8260 solution matrix spike solution over the course of 3 months. Gaseous standards should be prepared from stock solutions every two weeks but may not remain over 1 month.

The lab operator should monitor response factors to determine whether standards are degrading. In general, response factors will vary with tuning characteristics. However, comparison to response factors from fresh standard is suggested.

8.0 Method Calibration

In order to analyze samples the instrument must first be calibrated. The following subsections describe the system start-up and initial calibration procedures.

8.1 Initial System Calibration

Prior to performing analyses, the GC-MS must be tuned and calibrated to ensure system precision and accurate results.

Tuning of the GC-MS is accomplished using the HP Target Tune function in the BFB tune mode. The instrument automatically performs the tuning in an attempt to adjust parameters such that the spectrum of the compound 1,4-Bromofluorobenzene will meet the following specifications:

- Mass 50 15 percent to 40 percent of mass 95
- Mass 75 30 percent to 60 percent of mass 95
- Mass 95 base peak, 100 percent relative abundance
- Mass 96 5 percent to 9 percent of mass 95
- Mass 173 less than 2 percent of mass 174
- Mass 174 greater than 50 percent of mass 95
- Mass 175 5 percent to 9 percent of mass 174
- Mass 176 greater than 95 percent, but less than 101 percent of mass 174
- Mass 177 5 percent to 9 percent of mass 176

Following tuning, 50 ng of BFB must immediately be evaluated in the next blank or standard to determine the validity of the tune. Since BFB is one of the surrogate compounds that is included in every analysis, it can be monitored following any analysis. (See section 11.0 for details.) If the above criteria are not met, the instrument must be retuned or the problem found prior to proceeding.

Prior to performing analyses, the GC-MS must be calibrated to ensure system precision and accurate results. To calibrate the GC-MS, standards of the analytes, along with internal standards and surrogates are injected into reagent water, and measured by the method. (For convenience in standard preparation five standards are typically used: internal standards, surrogate standards, the 8260B VOC compounds, 8260B oxygenates, and the 8260B permanent gases.) A minimum of five concentration levels should be used during calibration for EPA Method 8260B. Each standard solution is analyzed under the identical parameters as samples will be analyzed. The end result is a calibration curve for each analyte. (Note: Certain regulatory protocols i.e. LARWQCB and specific client Data Quality Objectives (DQOs) may require fewer than five initial calibration standards)

To prepare a calibration curve:

1. Turn on the system.

2. Load a Method (e.g.0919full.mth) into the software. Schedule the autosampler for the correct Method (8260.mt).
3. 2016 AS:
Make sure that the purge tubes are clean for the 2016 AS prior to running the initial calibration curve.

Purge tubes are cleaned by rinsing out soil or water samples with tap water several times followed by two or more rinses with bottled drinking water. They are then baked in the GC oven for at least one temperature program to 230 degrees C. Tubes which contained high level samples or standards (defined as over the working range of the calibration curve) should be rinsed with methanol prior to cleaning. 2016 AS positions which contained samples with levels greater than three times the high standard should be used as a blank until all carryover compounds are eliminated.

Solatek AS:

Solatek AS vials should not be reused. Each sample VOA should be heated to 230 degrees C for approximately 15 minutes in a GC oven or in a toaster oven (without the blue cap), and allowed to cool until they can be safely handled. When cool, they should be recapped immediately. Each VOA can also be flushed with lab grade N₂, lab grade He, or ambient air using a 60 cc syringe.

4. 2016 AS:
Add 5 ng of the VOC compounds, gases and oxygenates (2.5 uL of 2 ug/mL standard), 5 ng of surrogates (2.5 uL of 2 ug/mL surrogate standard) and 50 ng of internal standards (2.5 uL of 20 ug/mL I.S.) from freshly prepared standards into 10 mL of reagent water in a syringe. Transfer water to the purge apparatus. Start the run.

Solatek AS:

Transfer 10 mL of reagent water to a syringe. Add 5 ng VOC compounds, gases and oxygenates (2.5 uL of 2 ug/mL standard) to the water in the syringe. Transfer the water to a VOA purge tube. The Solatek program will add 50 ng internal standard standards (5 uL of 10 ug/mL I.S.) and the remaining 10 mL water to the VOA.

5. 2016 AS:
Repeat Step 4 for 10 ng, 20 ng, 50 ng, 100 ng, 150 ng, 200 ng, 500 ng, 1000 ng, 1500 ng and 2000 ng of target and surrogate keeping the internal standards constant at 50 ng (2.5 uL of 20 ug/mL I.S.), using the appropriate volumes of the low standard and the working standard.

Solatek AS:

Repeat Step 4 for the 10 ng and 20 ng level by injecting 5 uL of the 2 ug/mL low standard and 1 uL of the 20 ug/mL working standard respectively. Program the Solatek to add 5 uL of the 10 ug/mL I.S. (50 ng) and the remaining 10 mL of water to the vials.

Repeat Step 4 for the 50 ng, 100 ng, 150 ng, 200 ng, and 250 ng levels injecting the appropriate volume of the 20 ug/mL working secondary standard. Program the Solatek to add 5 uL of 10 ug/mL surrogate for the 50 ng level, 10 uL of the 10 ug/mL surrogate for the 100 ng level, etc. Program the Solatek to add 5 uL of the 10 ug/mL I.S. and the remaining 10 mL of water to all the vials.

Repeat Step 4 for the 500 ng, 1000 ng, 1500 ng, and 2000 ng (do not add surrogate standard).

6. After completing the standards, quantitate and load the standards as the initial calibration. Evaluate the initial curve for linearity and response factors per the current version of EPA Method 8260B (or project specific DQO's).
 - a. The SPCC compounds must have RF's greater than

Chloromethane	0.1
1,1-Dichloroethane	0.1
Bromoform	0.1
Chlorobenzene	0.3
1,1,2,2-Tetrachloroethane	0.3
 - b. The CCC compounds must have %RSD less than 30%. The CCC's are vinyl chloride, 1,1-Dichloroethene, chloroform, 1,2-Dichloropropane, toluene, ethylbenzene.
 - c. Target compounds that have a %RSD less than 15% are considered to be linear within the calibration curve. For these compounds the average response factor is chosen as the calibration curve type.
 - d. Targets with %RSD greater than 15% may be treated in the following manner:

The analyst may drop either the high or low point of the curve thus achieving an abbreviated

or narrower linear range for the curve. If the high point is dropped, this compound will have a lower high point for the curve. If the low point is dropped, the reporting limit must be raised proportionately.

OR

The mean of the RSD values for all analytes in the calibration is less than or equal to 15%. The mean RSD must be applied to all analytes in the standard. The operator must supply a copy of the ICAL summary report to the end user.

- e. Targets with %RSD greater than 15% may be evaluated using a linear regression of the instrument response versus the concentration of the standards. The algorithms chosen in the software must be "linear regression" not "linear regression - force (0,0)." The regression calculation will generate a correlation coefficient (r) that is a measure of the "goodness of fit" of the regression line to the data. To use the linear regression algorithm, r must be greater or equal to 0.99
7. The calibration curve is checked for validity using a calibration standard from a second source. A mid-level (typically 50 ng on column) second source is introduced into the system in the same manner as the curve. In order for validity to be achieved, the second source must pass the requirements of a daily calibration i.e., SPCC's and CCC's must pass per method
- The calibration curve must be verified each working day by injecting standards. SPCCs must have RF's at least equal to the levels specified above. CCC compounds must be less than 20% for the system to be considered still within calibration.
8. If all the above CCC compounds do not meet the 20% criteria several options are available.
- a. The analyst may re-analyze the calibration standard, re-prepare the calibration standard and re-analyze and/or perform instrument troubleshooting and re-analyze.

- b. Target compounds may be individually screened to see if they meet the 20% criteria. If the target analytes necessary to meet the client DQO meet the 20% criteria, analysis may continue.
 - c. Data from those compounds which do not pass the 20% criteria may be flagged as estimated.
9. The RRT of each target analyte in each calibration standard must agree within .06 RRT units.

8.2 Initial Calibration Format

The initial calibration is saved in the format MMDD##.m where MMDD is the date and ## indicates method type.

9.0 Sample Collection

It is the responsibility of the field scientist (geologist, consultant, etc.), to collect all soil and water samples in manners which are consistent with protocol as set forth by federal, state and local regulatory agencies. The lab operator should assist in any manner possible but the ultimate responsibility lies with the sampler to assure that samples are taken in proper containers with preservatives if required. Care should be taken by the lab operator to insure that samples are not inadvertently contaminated in the lab.

9.1 Soil Samples

All soil samples should be collected in clean brass sample tubes (usually during drilling) or clean, laboratory approved, glass sample jars with Teflon liners. When brass sample tubes are used, the tube ends should be sealed with an impermeable material such as aluminum foil or Teflon tape. Next, the sample tubes should be capped with plastic caps and final-sealed with adhesive tape such as duct tape. It is important not to let the adhesive portion of the tape come in contact with the soil, as this adhesive material often contains toluene or other contaminants. Care should be taken to insure that the sample tubes are full and no headspace is present.

When using glass sample jars, they too must be completely filled to alleviate headspace. After filling, the jars should be securely capped with screw-on caps.

9.2 Water Samples

As is the case with soil samples, it is the responsibility of the field scientist to ensure that all water samples are collected in accordance with regulatory protocol. Water samples should be collected in glass

vials designed to prevent the loss of volatile compounds. The vials should be completely filled, then securely capped with screw-on caps. No headspace should be present within the vials. To check for headspace, invert the capped vial and look for air bubbles. As a general rule, air bubbles smaller than 1/4" in diameter are considered acceptable. Since H&P Mobile Geochemistry completes most of its analysis in the field the use of trip blanks trip blanks does not apply in many cases. However, if requested by the client, trip and field blanks are run to assess the potential contamination from shipping and field handling.

9.3 Soil Vapor Samples

As is the case with soil and water samples, it is the responsibility of the field scientist to ensure that all vapor samples are collected in accordance with regulatory protocol. Samples should be collected in gas tight syringes, Tedlar bags or other vessels designed to prevent the loss of volatile compounds. Holding times for the various sample vessels should be observed. H&P Mobile Geochemistry will observe maximum holding times of 72 hours for Tedlar bags, 2 hours for syringe samples.

Once vapor samples have been collected, they should immediately be placed on the purge and trap autosampler or in an appropriate container away from sunlight.

9.4 Laboratory Acceptance of Samples

The laboratory operator accepts samples from the field. Samples should be delivered with the appropriate chain-of custody (COC) form. The lab operator should immediately inspect the samples against the chain-of-custody. The COC must contain

- Unique sample identifier for all samples
- Date and time of sampling
- Source of sample including name, location and sample type
- Designation of MS/MSD
- Preservatives used
- Analyses required
- Name of collector
- Pertinent field data
- Serial numbers of custody seals and transport cases (if used)
- Custody transfer signatures and dates and times of sample transfer from the field to transporter and the lab
- Bill of lading or transporter tracking numbers (if applicable)

The laboratory operator will check the COC for the above criteria in reference to the applicable methods. If any discrepancies are found, the laboratory operator should document those on the COC or in the daily analysis logs. The custodian should also immediately inform the field personnel of the problem. No samples whose name or other information is

in question should be analyzed. Once sampling personnel have solved the problem analysis can begin. Samples awaiting analysis are temporarily stored in the mobile laboratory refrigerator separate from those containing analytical standards.

10.0 Handling and Preservation

The purpose of this section is to describe the standard procedures used to assure that samples can be related to their data.

10.1 Soil Samples

The following methods are employed for handling soil samples.

10.1.1 Non-Method 5035 samples

For sample preservation samples that are to be analyzed in the field by the mobile lab, they should be analyzed immediately or placed temporarily in the laboratory refrigerator until analyzed. Samples that are not analyzed in the field or require additional analysis not performed by the mobile laboratory will be preserved by being placed in an ice chest or appropriate cooler by H&P Mobile Geochemistry. Care must be taken to ensure the soil samples are kept at, or below, 4 degrees C. The holding time for soil samples should not exceed 14 days from the time of collection.

10.1.2 EPA Method 5035

If Method 5035 is required by the client, each sample will be subsampled immediately upon arrival at the mobile lab. Using an appropriate subsampling tool, such as a cut off 5 mL plastic syringe, quickly transfer approximately 5 g of sample into a prepared glass VOA containing 1 g preservative, 10 mL reagent water and a stir bar. Cap and record the weight of the sample. Prepare a duplicate following the same guidelines. Prepare a third sample as a dilution using 10 g of sample and 10 mL methanol. At this time, the two full strength samples are considered preserved and must be kept in the refrigerator at 4 degrees C and analyzed within 14 days.

10.2 Water Samples

Samples that are to be analyzed in the field by the mobile lab must be analyzed immediately or placed temporarily in the laboratory refrigerator

until analyzed. Samples that are not analyzed in the field or which require additional analysis not performed by the mobile laboratory will be preserved by adjusting the pH to < 2 . Because H&P Mobile Geochemistry uses preserved VOA bottles, this is done automatically. The samples are then placed in an ice chest or appropriate cooler by H&P Mobile Geochemistry and maintained at a temperature of 4 degrees C. Care must be taken to maintain water samples at a temperature of 4 degrees C while ensuring that the samples do not freeze, thus bursting the sample container. The holding time for water samples should not exceed 14 days from the time of collection.

10.3 Soil Vapor Samples

As is the case with soil and water samples, it is the responsibility of the field scientist to ensure that all vapor samples are collected in accordance with regulatory protocols. Samples should be collected in gas tight syringes, Tedlar bags or other vessels designed to prevent the loss of volatile compounds. Holding times for the various sample vessels should be observed. H&P Mobile Geochemistry will observe maximum holding times of 72 hours for Tedlar bags and 2 hours for syringe samples.

Once vapor samples have been collected, they should immediately be placed on the purge and trap autosampler or in an appropriate container away from sunlight.

11.0 Sample Preparation

Sections 11.1 through 11.5 describe the steps for sample preparation for both soil and water matrices.

11.1 Dilution Factor Calculation

The calibration curve is based on the mass analyte introduced into the instrument. Calculations for sample concentrations are based on the volume of sample analyzed. If one gram of soil or one mL of water are analyzed, the concentration of the analyte is reported as follows:

$$\frac{\text{Mass}}{\text{Sample mass}} \quad \text{OR} \quad \frac{\text{Mass}}{\text{Sample volume}}$$

To achieve lower detection limits, larger sample masses or volumes are required. If a five gram soil sample is purged, the results are for mass/5 g. To correctly report mass/1 g, the results must be divided by five.

If a 20 mL water sample is purged, the result must be divided by 20 to correctly report ng/1 mL.

The HP Chemstation software requires the analyst to input a "dilution factor" into the sample sequence to properly report sample concentration. This "dilution factor" is calculated by dividing 1 by the amount of sample used. If 5 g of soil are purged, the dilution factor is calculated by the equation $1 / 5 = 0.2$

If 20 mL of water is purged, the dilution factor is calculated by the equation $1 / 20 = 0.05$.

11.2 Laboratory Blank Preparation

Place a clean purge tube in the purge tube holder or autosampler position.

2016 AS:

1. Add 10 mL blank water (bottled drinking water, e.g. Palomar, Arrowhead, Evian) to a 10 mL syringe. Add 50 ng of I.S. (2.5 uL of the 20 ug/mL I.S.) and 50 ng of surrogate solution (2.5 uL of the 20 ug/mL surrogate solution.). The I.S. and surrogate solutions may be combined for daily calibration, sample and blank analysis, but they must be separate for initial calibration. Transfer to purge tube.

Solatek AS:

1. Add 10 mL blank water to a 10 mL syringe. Transfer to a clean VOA and place on autosampler. The autosampler will add 50 ng I.S. (5 uL of 10 ug/mL I.S.) and 50 ng surrogate solution (5 uL of 10 ug/mL surrogate solution) and add the remaining 10 water.

11.3 Low Level Soil Sample Preparation

Soil samples should be prepared using the following steps:

2016 AS:

1. Check the balance with the calibration weight of ASTM class 3. Record the weight and expected weight on the daily extraction log. The balance should be checked daily when samples are extracted or when the balance is moved.
2. Tare (zero) the balance with a clean purge tube on the balance tray. Add 2.0 g of soil to the tube with a clean

object such as a scoopula. Place the purge tube on the autosampler. Record the weight of the soil on the extraction log. Correctly input the dilution factor into the software.

3. Add 10 mL reagent water containing the appropriate I.S. and surrogate solutions to the sample. Quickly inject this into the purge tube in a manner that breaks up the soil particles.
4. If the soil sample is a clay it may be necessary to remove the tube from the autosampler and shake the sample vigorously for approximately 30 seconds.
6. Analyze the sample.

Solatek AS:

1. Same as 11.3.1.
2. Tare (zero) the balance with a clean VOA bottle on the balance tray. Add approximately 5 g of soil to the tube using a coring device (such as a cut-off 5 mL plastic syringe) for 5035 application. Add 1 g sodium bisulfate. Record the weight of the soil on the run log. Correctly input the dilution factor into the software.
3. Add 10 mL reagent water to the sample.
4. If the sample does not dissolve, shake the VOA for approximately 30 seconds.
5. Place on Solatek AS. Autosampler will add 50 ng I.S. (5 uL of 10 ug/mL I.S.), 50 ng surrogate solution (5 uL of the 10 ug/mL surrogate solution), and the remaining 10 mL water.
6. Analyze sample.

11.4 Medium/High Level Soil Sample Preparation

Soil samples should be prepared using the following steps:

For the purposes of this SOP, high level samples will be defined as those samples exhibiting a noticeable odor, are wet with nonaqueous material or those which have been prescreened by another technique and shown to be high level or those designated by the field as high level.

The following precautions may be taken by the lab operator in order to protect their health and safety. Because all lab operators have been OSHA 40 hour trained, and are considered personnel of supervisory level, it will be left to the lab operator to determine the level of precaution required on an individual and project basis. The following protections are available to the operator:

- a) Sample preparation using eye protection and gloves,
- b) Use of the well ventilated preparation room with doors open,
- c) Use of the laboratory hood when available,
- d) Store sample until more protection can be arranged.

If at any time the lab operator feels ill, especially after handling samples which may be high level, the operator should inform supervisory and/or medical personnel at the site and discontinue sample contact.

2016 AS:

1. Check the balance with the calibration weight of ASTM class 3. Record the weight and expected weight on the daily extraction log. The balance should be checked daily when samples are extracted or when the balance is moved.
2. Tare (zero) the balance with a 40-mL VOA bottle on the balance tray. Add 10 grams of soil to the tube with a clean object such as a scoop. Add 10mL of Purge and Trap grade Methanol to the VOA. Shake.
3. Add 10 mL reagent water to the 10 mL syringe and add the 50 ng of I.S./surr. Solution (2.5 uL of the 20 ug/mL solutions). Add an aliquot of the methanol extract to the syringe and add to the purge tube on the autosampler. Depending upon the expected concentration of analytes in the sample, aliquots of 25 uL, 10 uL , 2uL may be chosen. The respective dilution factors associate with these are 40, 100 and 500 respectively. Correctly input the dilution factor into the software.
4. Analyze the sample.

Solatek AS:

1. Check the balance with the calibration weight of ASTM class 3. Record the weight and expected weight on the daily extraction log. The balance should be checked daily when samples are extracted or when the balance is moved.
2. Tare (zero) the balance with a 40 mL VOA bottle on the balance tray. Add 10 g of soil to the tube with a clean object such as a scoop. Add 10 mL of Purge and Trap grade Methanol to the VOA. Shake.

3. Add 10 mL reagent water to the 10 mL syringe, add the aliquot of methanol extract to the VOA sample tube. Place VOA on the autosampler. The Solatek will add the final 10 mL water and the 50 ng of I.S./Su (5 uL of the 10 ug/mL solutions). Correctly input the dilution factor into the software.
4. Analyze the sample.

11.5 Water Sample Preparation

Prepare water samples using the following steps:

2016 AS:

1. Transfer 10 mL of the water sample to a syringe (assuming a clean sample)
2. If the water is suspected of having high levels, add 1 mL or 100 uL of the water to the 10 mL of reagent water in the syringe. Add 50 ng of the I.S./surrogate solution (2.5 uL of the 20 ug/mL solutions). Record the dilution factor for 10 mL of water as 0.1, for 1 mL as 1, and for 100 uL of water as 10. Input the dilution factor into the software.
3. Introduce into the purge apparatus.
4. Analyze the sample.

Solatek AS:

1. Transfer 20 mL of a clean water sample to a clean VOA. The autosampler will add 50 ng of I.S./surrogate solutions (5 uL of the 10 ug/mL solutions) and additional 2 mL of water to the VOA.
2. If the water is suspected of having high levels, add 1 mL or 100 uL of the water to the 10 mL of reagent water in the syringe. Record the dilution factor for 10 mL of water as 0.1, for 1 mL as 1, and for 100 uL of water as 10. Input the dilution factor into the software.
3. Transfer water to VOA purge tube. Autosampler will add 10 mL reagent water and 50 ng of I.S./surrogate solutions (5 uL of the 10 ug/mL solutions).
4. Analyze the sample.

11.6 Soil Vapor Samples Preparation

Prepare soil vapor samples using the following steps:

2016 AS:

1. Transfer 10 mL of reagent water to a syringe.
2. Add 50 ng of internal standard and surrogates (2.5 uL of the 20 ug/mL solutions).
3. Inject the water into the purge tube.
4. Inject the 10 mL of soil vapor into the purge tube, through the water.
5. Analyze the sample.

Solatek AS:

1. Transfer 10 mL water to a VOA purge vessel.
2. Add 20 mL soil vapor through VOA septa into the water in the vial.
3. Solatek AS will add 10 mL water and 50 ng I.S./surrogate solutions (5 uL of the 10 ug/mL solutions).
4. Analyze the sample.

12.0 Troubleshooting

If there are problems with instrumentation refer to the appropriate manual for troubleshooting options.

12.1 Preventive Maintenance

Preventive Maintenance (PM) is that set of procedures taken in an effort to assure that sample throughput is continued and that data quality is not degraded by system malfunctions. Although failure to perform preventive maintenance does not of itself produce poor quality data, the lack of such procedures may lead to earlier degradation of data and slower processing of samples.

This section treats PM in two sections: preparation and instrument PM.

12.1.1 Preparation PM

The primary area where preventable errors can enter throughout the preparation steps is the introduction of contamination. Preventive maintenance in the preparation steps primarily consists of thorough washing of glassware and other apparatus.

Purge tubes are cleaned by washing with tap water, rinsing with reagent water and baked prior to reuse. The GC oven is used to bake the purge tubes before reuse.

Purge tubes which had high level samples in them should receive methanol rinses prior to aqueous washing.

At washing, inspect the purge tubes for cracking at the top of the tube.

12.1.2 Instrument PM

There are five pieces of instrumentation involved in the analysis of volatile organics by GC/MS. They are the following:

- (1) the Mass Spectrometer
- (2) the Gas Chromatograph
- (3) the Purge and Trap concentrator
- (4) the Purge and Trap Autosampler
- (5) the computer system

H&P Mobile Geochemistry follows the manufacturer's recommendations on mass spectrometer PM. Monitoring and changing rough and diffusion pump oil and cleaning of source are performed at regular intervals. A full stock of parts are kept in the lab including but not limited to source filaments and cleaning apparatus.

Gas Chromatograph PM consists primarily of maintaining a full stock of consumable parts. Swagelok nuts, ferrules, septa, etc. allow the operator to repair, change worn parts quickly and to continue operation without loss of time. Tubing should be periodically inspected for cracks and possible leaks. Monitoring of the gas levels and rate of pressure loss may help discover problems.

The purge and trap concentrator can be monitored for leaks by observing the pressure of purging. In general the purge operates at a purge pressure of 4-5 psi. A pressure less than this may indicate a leak in the purge vessel.

Autosampler(AS) PM is mainly concerned with cleanliness of the purging system and the checking of leaks. Following high level samples and standards it is desirable to run blank water and purge gas through the AS.

The Computer system PM consists of keeping dust and dirt out of the components and backing up the data and methods as often as possible.

13.0 Data Acquisition, Calculation and Data Reduction

Once the system has been turned on, the daily calibration checked and a blank analyzed, samples may be analyzed. After preparing the sample extractions as directed above, load the control file and proceed with analyses.

13.1 System Start-Up - Mobile labs

In the mobile laboratories the mass spectrometer is maintained heated and under vacuum through the use of the inverter/battery system, generator or shore power. In the case of the 5972A, the gas chromatograph's detector B must also be maintained on to provide heat to the transferline and the MS. Helium is always supplied to the gas chromatograph but is automatically shut off when the GC is off through the electronic pressure control.

Upon leaving the garage:

1. Start the generators and wait for the delay period to ensure that the system is running on AC. Fill out excursion log.
2. Start air conditioners if needed.
3. Make sure all equipment has transitioned to generator power successfully.
4. Check the vacuum status. Diff. pump should be hot, MS should be around 145-165 degrees (230 source, 150 analyzer for the 5973A) and foreline pressure around 50- 70 mm.

13.2 Daily Calibration and Blank Analysis

1. Load the method files on P&T and GC-MS. Use sequencing for multiple GC-MS analyses. Use scheduling to run multiple P&T samples.
2. Standard Analysis

For the 2016 AS, 50 ng target (2.5 uL of the 20 ug/mL target solution), 50 ng of surrogate (2.5 uL of the 20 ug/mL surrogate solution), and 50 ng of I.S. (2.5 uL of the 20 ug/mL I.S.) are added by hand to 10 mL of reagent water in the syringe. This is introduced into the purge tube and analyzed.

For the Solatek, 50 ng of target (2.5 uL of the 20 ug/mL target solution) are added by hand and 50 ng of I.S./surrogate are added automatically by the Solatek (5 uL of the 10 ug/mL solutions) to an appropriate amount of reagent water in the syringe. Introduce into the purge tube and analyze.

3. Analysis of blank water

Add an appropriate amount of blank water to syringe. Add 50 ng each of surrogates and internal standards solutions to water. For 2016 AS, 2.5 uL of the 20 ug/mL I.S./surrogate solutions are added by hand. For the Solatek, 5 uL of the 10 ug/mL I.S./surrogate solutions are added automatically. Introduce into purge tube. Start run.

4. Remove and clean purge vessel (or if using Solatek, discarded purge vessel)

5. Evaluate standard and blank according to QC parameters for CCV and blank.

13.3 CCV and Blank Evaluation

CCV Evaluation - SPCC Compounds

All SPCCs must be within specifications of the method. If they are not, a second calibration can be analyzed. If all SPCC compounds do not meet criteria instrument, troubleshooting should be performed.

CCV Evaluation - CCC Compounds

If all CCC compounds are within 20% drift then all analytes are assumed to be within calibration. If any one CCC compound has a response factor that differs from its average by more than 20%, then each compound can be examined to determine whether it fits the 20% drift criteria. If all compounds of interest are within the 20% criteria then analysis can continue. Otherwise compound "hits" out of calibration must be flagged as estimated. Data quality objectives may be revised on a project by project basis to relax this requirement.

Blank evaluation

The blank must have all targets < R.L.

Once the system has been turned on, the daily calibration checked and a blank analyzed, samples may be analyzed. After preparing the sample extractions as directed above, the procedures outlined below should be followed for sample analysis.

13.4 Soil Sample Analysis

1. Prior to running soil samples, it is necessary to adjust the multiplication factor in the computer to the appropriate value. For example, for a two gram sample, the multiplication factor is 0.5. This factor can be adjusted in the Sample log table menu.

13.5 Water Sample Analysis

1. Prior to running water samples, it is necessary to adjust the multiplication factor in the computer to the appropriate value. For example, if a 10 mL water sample is analyzed, the multiplication factor to be entered would be 0.1. This factor can be adjusted in the Sample log table menu.

13.6 Soil Vapor Sample Analysis

1. Prior to vapor samples, it is necessary to adjust the multiplication factor in the computer to the appropriate value. For example, if a 20 mL vapor sample is analyzed, the multiplication factor to be entered would be 0.05. This factor can be adjusted in the Sample log table menu.

13.7 Data Processing

The GC/MS data system will perform peak integration of the target ion chromatograms. If parameters for thresholding and peak width are correctly set (see HP manuals), the algorithm used by the Hewlett-Packard instruments should correctly integrate 90% or greater of the ion chromatograms correctly. It is recommended that the operator allow this to occur and to simply view or monitor the result.

Sometimes manual integration is necessary. The following are some common examples in Method 8260 where manual integration may be necessary.

1. Gaseous VOCs at low levels
Due to noise at the top of the peak the program may only choose one half of the peak to integrate.
2. Peak tailing

Excessive peak tailing can add significant area to a peak. The peak should be cut off such that the peak is as symmetrical as possible.

3. Unresolved peaks

The program may pick the wrong peak to quantitate. E.g. the internal standard chlorobenzene-d5 is not always completely resolved from chlorobenzene and the latter can be chosen. This may be manually integrated using a drop to baseline method.

4. Interference

Interference with the target ion may require manual integration. E.g. the surrogate 1,4 bromofluorobenzene is often interfered by fuel hydrocarbons.

5. Noise in the baseline

Noise in the baseline may add area to compounds which may incorrectly increase the amount detected. This is more often a problem at the lower levels. A noisy baseline can be witnessed by several small "bumps" in the ion chromatogram preceding or following the peak of interest. If noise is evident it shall be acceptable to manually integrate from the top of the noise line instead of the "zero" baseline level.

When manual integration is necessary, it must be documented. The operator should follow the following guidelines.

Check to see how the particular compound integration is performed on the standards (ICAL, CCAL). Is it baseline, valley to valley, etc?

Manually integrate the compound in the new data file in a manner as consistent with (a) as possible.

Print copies of the computer integrated and manually integrated ion chromatogram showing the integration.

Document the reason for the manual integration (see 1-4 above) sign and initial the hardcopies.

13.8 Qualitative Analysis

For the qualitative identification of each compound the analyst will follow the guidelines in SW-846 Method 8260B Revision 2 Dec 1996 Section 7.6.

13.9 Reporting Limits

The normal reporting limits are nominally 5-10 ng of compound on column. This corresponds to 5-10 ug/kg for a one-gram soil sample or 1-2 ug/L for 5 mL water or vapor samples. These limits should be compared annually to the MDL's to make certain that they are appropriate. Depending upon client data quality objectives (DQO's) the H&P Mobile Geochemistry may report lower than these values. The reporting limits, however, should be no lower than twice the MDL calculated at initial instrument checkout and updated yearly or at major instrument overhaul. Results reported that are between two and five times the MDL should be flagged with the "J" flag as a quantitative estimate. The "J" flag means the concentration reported is between the MDL and the EQL. Reporting limits may be raised to accomplish specific data quality objectives as clients or regulatory agencies dictate with no effect on the data or flags required.

When samples are diluted for 8260B, the reporting limits are raised proportionately. All multipliers must also be applied to the reporting limits as well. Dilutions are recorded on the daily extraction/run logs and are entered into the HP chemstation software for the particular analysis.

13.10 Precision, Bias and Working Range

The applicable working range of the analyses for the EPA Method 8260B is dependent upon the concentrations of the calibration standards used while developing the calibration curve for the instrument. This calibration curve is discussed in Section 8.0. Generally, the working range of the instrument is between the detection limit for the analyte and the concentration of the high standard used for system calibration (normally 2000 ng). In the event that sample results are greater than the amount used for the high standard, then sample dilution may be necessary. If the sample result is greater than the high standard then the sample must be diluted and reanalyzed or the "E" flag (estimated value) used to qualify the data. In the case of soil vapor samples, the "E" flag will be used if the sample is greater than 150% of the high standard per LARWQCB protocol. "E" flag means the analyte amount exceeds calibration range and the amount reported is quantitated by extrapolation.

14.0 Computer Hardware and Software

Agilent Technologies (HP) enviroquant software running on Pentium (or equivalent) PC's under Windows NT operating system is the data acquisition system. Chromatograms and quantitation reports are printed out on laser printers.

15.0 Data Management and Records Management

Document control is the process by which the documentation associated with samples and sample data are tracked and monitored.

15.1 Chain of Custody Record

A Chain of Custody Record serves to note the disposition of the samples, from the time of collection to laboratory receipt. This form should be filled out at the time of collection and signed by all persons collecting, relinquishing and receiving samples. All samples must be documented on an appropriate Chain of Custody form.

15.2 Sample Run Logs

H&P Mobile Geochemistry maintains a Sample Run Log for all samples analyzed. These logs are kept within a logbook, one of which is located in each van. A new log is prepared for each work day. The following information is included on the run logs:

- Date of operation
- H&P Mobile Geochemistry job number
- Operator name
- Instrument No.
- Analysis type
- Solvent type
- Extraction method
- Matrix Spike, Matrix Spike Duplicate information
- Sample extraction data (sample amount, solvent amount, dilution factor, etc.)
- Calibration Standard identification
- Sample Analysis data

Also located in each van are instrument and excursion logs. The instrument log is used to document problems and subsequent corrective action for the instrumentation (excessive column bleed, baseline irregularities, interference, etc.). The excursion log documents where and when the particular job takes place, the type of analysis, and operating conditions (weather, temperature, etc.). The excursion log should be filled out for each new job.

15.3 Reporting

The Data Package

The analyst will prepare a data package for Reporting and Review. For EPA Method 8260B the package will be produced on a daily basis corresponding to the 12-hour window of operations. The package will

consist of the following in the order listed or as near as possible to that order:

- a) The Original COCs for the samples analyzed during that day
- b) The daily run logs
- c) The BFB tuning report
- d) Edited Quantitation reports from the daily initial Calibration (ICAL) or the passing Continuing Calibration Verification (CCV)
- e) The Response factor summary (if ICAL) or the Evaluation of CCV (if daily CCV)
- f) Edited quantitation report from the Initial Calibration verification (ICV) (If ICAL)
- g) ICV summary, if done showing all compounds <25%D
- h) Edited quantitation report from the LCS
- i) LCS Summary showing percent recovery and control limits
- j) Edited quantitation report from a blank analysis
- k) Edited quantitation reports for all analyses.
- l) Edited quantitation for MS/MSD if applicable.
- m) MS/MSD summary with control limits.

In addition to the above daily package, other data pertinent to the project should be supplied to the data entry person(s) and the reviewer. Such project specific information as out of control events and associated recommendations for qualifier flags, corrective actions, MDL studies should be added to the above package if required by project DQOs.

The analyst will assure that the data is in the proper format above before passing it on for data entry or review.

Report Review

Data Review will consist of a third party review of the data generated during this project. The data reviewer will

1. Folder
Project Number
Project Name (site)
Project date
2. Accounting Information
Lab confirmation form
Report to information
Billing to information
3. Print report on plain paper
4. From Chain of Custody Record confirm:
 - a. Project information (client, project No. etc.)
 - b. Correct dates
 - c. Special instructions or out of control items

- d. Does the COC sample names match the report.
 - e. Check the COC for the following items:
 - f. Unique sample identifier for all samples
 - g. Date and time of sampling
 - h. Source of sample including name, location and sample type
 - i. Designation of MS/MSD
 - j. Preservatives used
 - k. Analyses required
 - l. Name of collector
 - m. Pertinent field data
 - n. Serial numbers of custody seals and transport cases (if used)
 - o. Custody transfer signatures and dates and times of sample transfer from the field to transporter and the lab
 - p. Bill of lading or transporter tracking number (if applicable)
5. From Raw Data:
- Organize raw data in order of date
 - Go through the raw data page by page
 - Date - is the correct date analyzed listed
 - BFB tuning - does it pass?
 - Blank - is it clean
 - ICAL - does it meet project QC requirements (if applicable)
 - ICV - does it meet project QC requirements?
 - CCAL - is it acceptable under project QC
 - LCS - within specifications
 - Sample - identify each individual set of data
6. Using the final report forms, check that the raw data from above is correctly entered in the proper places on the forms. Apply data qualifier flags to the data as necessary according to project requirements.
7. Edits
- With edited copy of rough draft
 - Page by page make all changed marked in red
 - Print out on letterhead
 - Compare final to rough draft
8. Mail
- Prepare the report; COC, chromatograms (if needed)
 - Make a complete copy for our file

Final Report

The following information should be included in each H&P Mobile Geochemistry report on H&P Mobile Geochemistry letterhead:

- client (name and address)
- client job number / project name
- site location (location of analysis)
- test methods
- dates samples received
- dates samples collected
- dates samples analyzed
- analyst
- sample results in table form titled Report Summary
- sample identification number
- units reported (mg/kg or ug/l)
- amount found and units
- detection limit for each sample
- QA/QC report for each method used (including deviations)
- unique laboratory project ID number
- identification of flagged data (including data outside quantitation levels)
- chain of custody (including sample dates and time)
- cover letter (including signature and title page)
- a brief description of the test method
- narrative (if needed)
- a description of any unusual or notable events or conclusions, including samples that did not meet NELAC sample acceptance requirements

Any analytical testing provided by a subcontractor will be reported by the subcontractor on their letterhead, separate from the H&P Mobile Geochemistry report.

After the final laboratory report is issued, the report will remain unchanged. Any amendments to the report will be made as separate reports and will include a statement of amendment or supplement to the original report. H&P Mobile Geochemistry will notify the client promptly in writing of any defective measuring or validity problems with data.

H&P Mobile Geochemistry takes the necessary steps to ensure the confidentiality of its report, by providing data only to the client by phone, fax, e-mail or mail.

H&P Mobile Geochemistry shall certify that the test results meet all the requirements of ELAP or shall provide a reasonable explanation as to why they do not.

16.0 Quality Assurance and Quality Control

Quality Assurance (QA) and Quality Control (QC) are a set of procedures and conditions designed to maximize the precision and accuracy of the analytical process. The procedures are also designed to maximize the precision and accuracy of the analytical process. QA/QC is a continuous process requiring verification by inspection and, if necessary, appropriate corrective action. Listed below are key items used to ensure proper QA/QC. A brief description of each term is included, along with H&P Mobile Geochemistry and regulatory requirements.

- Initial Calibration
- Continuing Calibration
- Detection Limits
 - Minimum detection limit (MDL)
 - Estimated Quantitation Limit (EQL)
 - Reporting Limit
- Spiking
- Blanks
- Percent Recovery Calculation
- Percent Relative Difference
- Laboratory Control Limits
- Sample Run Logs
- Chain-of-custody

16.1 Initial Calibration (ICAL)

Prior to performing sample analysis, the GC must be initially calibrated. Following a clean blank analysis, at least five levels of target compounds along with surrogates and internal standards are introduced into the GC/MS system and the total area under each peak determined. These values are entered into the software. The computer will construct the calibration curve according to one of several methods. Hardcopy output of the chromatograms should be saved and kept with the instrument throughout the lifetime of the ICAL. The hardcopy output should list the method used to generate the ICAL curve. The ICAL is considered valid until the continuing calibration fails or a major change in the instrument operating condition occurs.

16.2 Tune/Continuing Calibration (CCAL)

The BFB tune as outlined in section 8.2 must be performed prior to analysis of any standards and repeated every 12 hours if samples or standards are to be analyzed. The calibration of the instrument is checked prior to analyzing samples and repeated every 12 hours if samples or standards are to be analyzed. The continuing calibration (CCAL) or continuing calibration verification (CCV) uses a second source of the standard to check the validity of the ICAL. Normally a standard corresponding to the midpoint of the curve is chosen. Response of the compounds of interest must be within that specified by the method for the

continuing calibration check compounds (CCCs) for the curve to be valid. If not all compounds are of interest only those being analyzed need to be checked.

16.3 Detection Limits

16.3.1 Minimum Detection Limit

The method detection limit (MDL) is the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero. The laboratory shall establish MDLs for each method, matrix, and analyte for each instrument the laboratory plans to use for the project. The laboratory shall revalidate these MDLs at least once per twelve-month period. The laboratory shall maintain proof of the MDL demonstrations (i.e., before project samples are analyzed) and upon request in the format specified in Section 8. Results less than or equal to the MDL shall be reported as the MDL value and flagged with a "U" (see Section 8).

Laboratories participating in this work effort shall demonstrate the MDLs for each instrument, including confirmatory columns, method of analysis, analyte, and matrix (i.e., water and soil) using the following instructions:

- (1) Estimate the MDL using one of the following:
 - a) The concentration value that corresponds to an instrument signal/noise ratio in the range of 2.5 to 5, or
 - b) The concentration equivalent of 3 times the standard deviation of replicate measurement of the analyte in reagent water, or
 - c) The region of the standard curve where there is a significant change in sensitivity (i.e., a break in the slope of the standard curve).
- (2) Prepare (i.e., extract, digest, etc.) and analyze seven samples of a matrix spike (ASTM Type II water for aqueous methods, Ottawa sand for soil methods, glass beads of 1 mm diameter or smaller for metals) containing the analyte of interest at a concentration three to five times the estimated MDL.
- (3) Determine the variance (S^2) for each analyte as follows:

$$S2 = \frac{1}{n-1} \left[\sum_{i=1}^n (x_i - \bar{x})^2 \right]$$

where x_i = the i th measurement of the variable x and
 \bar{x} = the average value of x

$$\bar{X} = \frac{1}{n} \sum_{i=1}^n x_i$$

- (4) Determine the standard deviation (s) for each analyte as follows:

$$s = (S2)^{1/2}$$

- (5) Determine the MDL for each analyte as follows:

$$MDL = 3.14(s)$$

(note: 3.14 is the one-sided t -statistic at the 99 percent confidence level appropriate for determining the MDL using 7 samples)

- (6) If the spike level used in step 2 is more than 5 times the calculated MDL, repeat the process using a smaller spiking level.

Where multiple instruments are used, the MDL used for reporting purposes shall represent the least sensitive instrument.

16.3.2 Estimated Quantitation Limit (EQL) formerly called Practical Quantitation limit (PQL).

It should be noted that this detection limit might vary due to low sample amounts or dilutions. In most cases, H&P Mobile Geochemistry reports EQL values roughly 5-10 times the MDL. These values are in accordance with the recommended values

16.3.3 Reporting Limit

The reporting limit is a limit below which regulators or clients are uninterested or will not regulate. Thus 8260 compounds that are detected but are below the established reporting limit are reported as non-detect.

16.4 Blanks

A Method Blank is an analyte free matrix sample, run through the sample preparation and analysis procedures of those used for samples. These blanks check the levels of contamination for the method. Blanks must be run at a frequency of one per batch of samples or preparation method. If a contaminate is found the source of contamination must be investigated and measures taken to correct, minimize or eliminate the problems if:

- a) the target analytes in a reagent blank are higher than the reporting limit (dilution factors taken into account) in effect at the time
- b) the blank contamination exceeds a concentration greater than 1/10 of the measured concentration of any sample in the associated blank sample batch or the blank contamination exceeds the concentration present in the samples and is greater than 1/10 of the specified regulatory limit.

16.5 Matrix Spike/Matrix Spike Duplicate and Lab Control Sample

The Matrix Spike (MS) and Matrix Spike Duplicate (MSD) are two aliquots of the same sample, which have been which have been spiked with a known concentration of a target analyte. Together, the results of these two sample spikes are used to indicate method precision and accuracy, and to characterize the effects, if any, of matrix interference. H&P Mobile Geochemistry uses a minimum of 5 percent of all samples for these spikes.

When the results of the matrix spike analysis indicate a problem due to the sample matrix, a Laboratory Control Sample (LCS) is analyzed to verify that the laboratory can perform the analysis in a clean matrix. A LCS is an aliquot of a clean matrix similar to the sample matrix, bottled water for water samples and clean sand for soil samples. The LCS is spiked with the same analytes at the same concentrations as the matrix spike and is analyzed with the sample batch. If matrix spike and matrix spike duplicate are left unattended on an auto sampler then the analyst should include a LCS with each batch of samples. If, however, the MS/MSD analyses are reviewed within the applicable 12 hour period and found to be acceptable it is not necessary to analyze a LCS. The LCS results are only needed if the MS/MSD analysis indicate a sample matrix interference.

16.6 Percent Recovery Calculation

The values for the MS and MSD are used to calculate the Percent Recovery (PR), an estimate of the accuracy of the analytical process. The Average PR can be calculated using the following general equation:

$$\text{Average PR} = (\text{MS} + \text{MSD}) / 2 \times 100$$

SA

where: PR = Percent Recovery
MS = Matrix Spike Result - Sample Background Analyte Result
MDS= Matrix Duplicate Spike Result - Sample Background Analyte Result
SA = Spiked Amount

H&P Mobile Geochemistry calculates the PR for each set of spikes (MS and MSD) and the resultant value is included in the QA/QC section of the report.

16.7 Relative Percent Difference

The Relative Percent Difference (RPD) is calculated from MS and MSD data and is used to estimate overall method precision. The RPD can be calculated using the following general equation:

$$RPD = \frac{MS - MSD}{(MS + MSD)/2} \times 100$$

This RPD data is calculated for each set of spikes (MS and MSD) and is included in the QA/QC section of the report.

16.8 Laboratory Control Limits

Each certified laboratory establishes their own set of Laboratory Control Limits (LCL's). These limits include criteria such as recovery ranges and maximum allowable RPD's. H&P Mobile Geochemistry has established the following preliminary list of control limits for EPA Method 8260B from the method:

	Average percent recovery	Percent difference
Soil		
1,1-Dichloroethene	65-135	<30
Trichloroethene	65-135	<30
Chlorobenzene	65-135	<30
Benzene	65-135	<30
Toluene	64-135	<30
Water		
1,1-Dichloroethene	75-125	<20
Trichloroethene	75-125	<20
Chlorobenzene	75-125	<20
Benzene	75-125	<20
Toluene	74-125	<20

Surrogates

4-Bromofluorobenzene	65-135 soil
	75-125 water/vapor
dibromofluoromethane	65-135 soil
	75-125 water/vapor
toluene -d8	65-135 soil
	75-125 water/vapor
1,2-Dichloroethane-d4	52-149 soil
	62-139 water

Spiked matrix/duplicate pairs which exceed this limit are either re-analyzed or a matrix blank is spiked (Lab Control Spike) to check method performance.

Samples whose surrogate exceeds the limits are re-analyzed one time.

17.0 References

Leaking Underground Fuel Tank (LUFT) Manual, California State Water Resources Control Board, May 1988. This contains the method for Total Petroleum Hydrocarbons (TPH)

Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), U.S.E.P.A including Update III, December 1996

Quality Systems Manual, H&P Mobile Geochemistry, Inc. most recent version



H&P EPA Method 8260B (EPA Method 5030/5035 Prep.)

Target Compounds Standard Compounds List

	E.Q.L. soil ug/kg	E.Q.L. water ug/L
1,1,1,2-Tetrachloroethane	5	1
1,1,1-Trichloroethane	5	1
1,1,2,2-Tetrachloroethane	5	1
1,1,2-Trichloroethane	5	1
1,1-Dichloroethane	5	1
1,1-Dichloroethene	5	1
1,1-Dichloropropene	5	1
1,2,3-Trichlorobenzene	5	1
1,2,3-Trichloropropane	5	1
1,2,4-Trichlorobenzene	5	1
1,2,4-Trimethylbenzene	5	1
1,2-Dibromo-3-chloropropane	5	1
1,2-Dibromoethane	5	1
1,2-Dichlorobenzene	5	1
1,2-Dichloroethane	5	1
1,2-Dichloropropane	5	1
1,3,5-Trimethylbenzene	5	1
1,3-Dichlorobenzene	5	1
1,3-Dichloropropane	5	1
1,4-Dichlorobenzene	5	1
2,2-Dichloropropane	5	1
2-Chlorotoluene	5	1
4-Chlorotoluene	5	1
Benzene	5	.5
Bromobenzene	5	1
Bromochloromethane	5	1
Bromodichloromethane	5	1
Bromoform	5	1
Bromomethane	5	1
Carbon Tetrachloride	5	1
Chlorobenzene	5	1
Chloroethane	5	1
Chloroform	5	1
Chloromethane	5	1

cis-1,2-Dichloroethene	5	1
cis-1,3-Dichloropropene	5	1
Dibromochloromethane	5	1
Dibromomethane	5	1
Dichlorodifluoromethane	5	1
Ethylbenzene	5	.5
Hexachlorobutadiene	5	1
Isopropylbenzene	5	1
m,p-Xylene	10	1
Methylene Chloride	5	1
Napthalene	5	1
n-Butylbenzene	5	1
n-Propylbenzene	5	1
o-Xylene	5	.5
p-Isopropyltoluene	5	1
sec-Butylbenzene	5	1
Styrene	5	1
tert-Butylbenzene	5	1
Tetrachloroethene	5	1
Toluene	5	.5
trans-1,2-Dichloroethene	5	1
trans-1,3-Dichloropropene	5	1
Trichloroethene	5	1
Trichlorofluoromethane	5	1
Vinyl Chloride	5	1

Additional Compounds which can be added at client request
(may increase per sample costs)

Diisopropyl ether (DIPE)	5	1
Ethyl-t-butyl ether (ETBE)	5	1
MTBE	5	1
t-Amyl-methyl ether (TAME)	5	1
t-Butanol (TBA)	25	5

Other Compounds are amenable to analysis by EPA Method 8260B

APPENDIX D
QUALITY ASSURANCE PROJECT PLAN

Quality Assurance Project Plan Variances and Additions to the March ARB QAPP

The following clarifications, additions, and changes apply to the Final Work Plan and Quality Project Plan for the Basewide RI/FS, March ARB, CA (March 1999). In accordance with instructions in the Preface of the QAPP, this document is to be used as an appendix to the project plan with citations for the QAPP sections and tables being amended. The proposed technical approach includes lab-specific performance information STL Los Angeles has applied to past AFCEE projects.

STL Los Angeles will be performing the analytical work for this project. This is a change from the laboratory listed in the March ARB QAPP, and therefore requires variances in addition to those already approved. The following variances apply to work performed by STL Los Angeles.

Methods 8270C for Semivolatile Organics and TO-3 for Total Volatile Petroleum Hydrocarbons and BTEX in Air are not included in the March ARB QAPP, and constitute additions to the plan.

Section 6.9.1 Subcontractors

STL Los Angeles, formerly Quanterra Analytical Services, the laboratory originally listed as providing backup analytical services for March ARB, will be the primary laboratory. The facility is still located at 1721 S. Grand Ave., Santa Ana, CA 92705, telephone 714/258-8610. The current project manager is Sabina Sudoko and the current QA officer is Linda Scharpenberg.

Section 5.4.4.3 Evaluation of Surrogate Spikes

- | | |
|----------------|--|
| Requirement: | Whenever surrogate recovery is outside the acceptance limits, corrective action must be performed. After the system problems have been resolved and system control has been reestablished, reprepare and reanalyze the sample. |
| Proposed: | Reextraction and reanalysis is not required when poor surrogate recoveries are caused by sample dilution or when there is chromatographic evidence of matrix interference. In the later case, the laboratory will document the condition in the report case narrative and be prepared to supply raw data supporting the narrative. |
| Justification: | Reanalysis for obvious and well-documented matrix interferences does not improve data quality, and jeopardizes timely reporting. |

Section 5.7-18 SW9056 – Common Anions

- | | |
|-------------------|---|
| Requirement: | The use of method SW9056 for the analysis of Common Anions – Bromide, Chloride, Fluoride, Nitrate, Nitrite, Phosphate and Sulfate. |
| Proposed: | Change the analytical method for Fluoride to SM4500F-C and for Phosphate to EPA 365.3. |
| Justification: | The lab does not hold current certification for either Fluoride or Phosphate by Method SW9056. The lab does hold certification for Fluoride by Method SM4500F-C and for Phosphate by EPA 365.3. Use of these methods will have no impact on data quality. |
| Requirement: | Meet the Reporting, QC Limits as stated in Tables 5.7-18 and 5.7-19 of the MARCH QAPP. |
| Proposed: | The laboratory proposes to use the RL's and QC Limits as stated in the following table. |
| RL Justification: | Reporting Limits are equal to or lower than those stated in the MARCH QAPP. MDL data supports the Lower RL's for both soil and water. |
| QC Justification: | QC limits are equal to or tighter than those stated in the March QAPP except for Chloride by method SW9056, (90–110), Fluoride by method SM4500F-C, (80-120) and Phosphate by method EPA365.3, (80-120). Historical QC data supports the wider limits. |

Common Anion	Water			Soil		
Method SW9056	Proposed Accuracy (%R)	Proposed Precision (%)	Proposed RL (µg/L)	Proposed Accuracy (%R)	Proposed Precision (%)	Proposed RL (mg/kg)
Bromide	90-110	≤ 20	0.5	90-110	≤ 30	2.5
Chloride	90-110	≤ 20	1.0	90-110	≤ 30	5.0
Nitrate	90-110	≤ 20	0.1	90-110	≤ 30	0.5
Nitrite	90-110	≤ 20	0.1	90-110	≤ 30	0.5
Sulfate	90-110	≤ 20	1.0	90-110	≤ 30	5.0
Method SM4500F-C	Proposed Accuracy (%R)	Proposed Precision (%)	Proposed RL (µg/L)	Proposed Accuracy (%R)	Proposed Precision (%)	Proposed RL (mg/kg)
Fluoride	80-120	≤ 20	0.1	80-120	≤ 30	0.5
Method EPA 365.3	Proposed Accuracy (%R)	Proposed Precision (%)	Proposed RL (µg/L)	Proposed Accuracy (%R)	Proposed Precision (%)	Proposed RL (mg/kg)
Phosphate	80-120	≤ 20	0.05	80-120	≤ 30	0.25

Section 5.7-18

SW9056 – Common Anions, Tables 5.7-20

Requirement: Initial calibration prior to sample analysis.
Proposed: Initial calibration prior to sample analysis or as needed.
Justification: The calibration is verified with ICV/ICB pair before sample analysis. In the event that the ICV/ICB fail to meet criteria the instrument is then recalibrated.

Requirement: Retention Time window criteria - ± 3 times standard deviation for each analyte retention time over an 8 hour period.
Proposed: Retention Time window criteria - $\pm 10\%$ of the true value for each analyte retention time over an 8 hour period. The true value is the average of the initial calibration standards for each analyte.
Justification: Slight changes in retention time are expected with changes in the concentration of calibration standards. No impact on data quality is expected.

Section 5.7.2.3

SW8260B – Volatile Organics, Tables 5.7-9 and 5.7-10

8260 Constituent	Water			Soil			
	Proposed QC limit (%R)	Proposed RPD (%)	Proposed RL (µg/L)	Proposed QC limit (%R)	Proposed RPD (%)	Low Level RL (mg/kg)	Medium Level RL (mg/kg)
1,1,1,2-Tetrachloroethane			1.0			0.005	0.250
1,1,1-Trichloroethane	75-125	≤ 20	1.0	65-135	≤ 30	0.005	0.250
1,1,2,2-Tetrachloroethane			1.0			0.005	0.250
1,1,2-Trichloroethane			1.0			0.005	0.250
1,1-Dichloroethane	72-125	≤ 20	1.0	62-135	≤ 30	0.005	0.250
1,1-Dichloroethene	75-125	≤ 20	1.0	65-135	≤ 30	0.005	0.250
1,1-Dichloropropene			1.0			0.005	0.250
1,2,3-Trichlorobenzene			1.0			0.005	0.250
1,2,3-Trichloropropane			1.0			0.005	0.250
1,2,4-Trichlorobenzene			1.0			0.005	0.250
1,2,4-Trimethylbenzene			1.0			0.005	0.250
1,2-Dichloroethane	68-127	≤ 20	1.0	58-137	≤ 30	0.005	0.250
1,2-Dichlorobenzene			1.0			0.005	0.250
1,2-Dibromo-3-chloropropane			2.0			0.010	0.50
1,2-Dichloropropane			1.0			0.005	0.250
1,2-Dibromoethane (EDB)			1.0			0.005	0.250
1,3,5-Trimethylbenzene			1.0			0.005	0.250
1,3-Dichlorobenzene			1.0			0.005	0.250
1,3-Dichloropropane			1.0			0.005	0.250
1,4-Dichlorobenzene			1.0			0.005	0.250
2,2-Dichloropropane			1.0			0.005	0.250
2-Chlorotoluene			1.0			0.005	0.250
4-Chlorotoluene			1.0			0.005	0.250
Benzene	75-125	≤ 20	1.0	65-135	≤ 30	0.005	0.250
Bromobenzene			1.0			0.005	0.250
Bromochloromethane			1.0			0.005	0.250
Bromodichloromethane	75-125	≤ 20	1.0	65-135	≤ 30	0.005	0.250
Bromoform			1.0			0.005	0.250
Bromomethane			2.0			0.010	0.500
n-Butylbenzene			1.0			0.005	0.250
Sec-Butylbenzene			1.0			0.005	0.250
Tert-Butylbenzene			1.0			0.005	0.250
Carbon Tetrachloride	62-125	≤ 20	1.0	52-135	≤ 30	0.005	0.250
Chlorobenzene	75-125	≤ 20	1.0	65-135	≤ 30	0.005	0.250
Dibromochloromethane			1.0			0.005	0.250
Chloroethane			2.0			0.010	0.500
Chloroform	74-125	≤ 20	1.0	64-135	≤ 30	0.005	0.250
Chloromethane			2.0			0.010	0.500
Dibromochloromethane			1.0			0.005	0.250
Dibromomethane			1.0			0.005	0.250
Dichlorodifluoromethane			2.0			0.010	0.500
cis-1,2-Dichloroethene	75-125	≤ 20	1.0	65-135	≤ 30	0.005	0.250
Trans-1,2-Dichloroethene	75-125	≤ 20	1.0	65-135	≤ 30	0.005	0.250
Cis-1,3-Dichloropropene			1.0			0.005	0.250
Trans-1,3-Dichloropropene			1.0			0.005	0.250

Section 5.7.2.3

SW8260B – Volatile Organics, Tables 5.7-9 and 5.7-10. Concluded

8260 Constituent	Water			Soil			
	Proposed QC limit (%R)	Proposed RPD (%)	Proposed RL (µg/L)	Proposed QC limit (%R)	Proposed RPD (%)	Low Level RL (mg/kg)	Medium Level RL (mg/kg)
Ethylbenzene	75-125	≤ 20	1.0	65-135	≤ 30	0.005	0.250
Hexachlorobutadiene			1.0			0.005	0.250
Isopropylbenzene			1.0			0.005	0.250
p-Isopropyltoluene			1.0			0.005	0.250
Methylene Chloride			1.0			0.005	0.250
Naphthalene	75-125	≤ 20	1.0	65-135	≤ 30	0.005	0.250
n-Propylbenzene			1.0			0.005	0.250
Styrene			1.0			0.010	0.500
Tetrachloroethene	71-125	≤ 20	1.0	61-135	≤ 30	0.005	0.250
Toluene	74-125	≤ 20	1.0	64-135	≤ 30	0.005	0.250
Trichloroethene	71-125	≤ 20	1.0	61-135	≤ 30	0.005	0.250
Trichlorofluoromethane			2.0			0.010	0.500
Vinyl Chloride	46-134	≤ 20	1.0	36-144	≤ 30	0.010	0.500
M& P- Xylenes	75-125	≤ 20	1.0	65-135	≤ 30	0.005	0.250
O-Xylenes	75-125	≤ 20	1.0	65-135	≤ 30	0.005	0.250
Surrogates							
4-Bromofluorobenzene	75-125			65-135			
1,2-Dichloroethane - d4	62-139			52-149			
Toluene – d8	75-125			65-135			
Dibromofluoromethane	75-125			65-135			

1-Chlorohexane: This compound will not be reported as it is not in the STL Los Angeles list of analytes for method 8260 and is not a compound of concern at March ARB. There is no calibration, MDL, RL or IDOC data to support adding this analyte to the list.

RL Justification: Examination of the raw data for compounds listed in the approved variances for the AFCEE 3.0 QAPP at or slightly below the RL demonstrates that the chromatography is not reliable at these levels. Proposed RL's are elevated to ensure that the RL is at least a factor of two greater than the most recently established laboratory MDL, as required by Section 5.4.3.2 of the March ARB QAPP, and to ensure that the laboratory is able to meet the calibration linearity requirements.

QC Justification: The proposed shorter spiking list contains all compounds of concern at March ARB. Acceptance limits are consistent with the March ARB QAPP

Method SW8270C – Semivolatile Organics

Method 8270C is not included in the March ARB QAPP, and the following section, i.e., Section 7.2.10 from Version 3.0 of the AFCEE QAPP, is provided here for reference. Variances to AFCEE QAPP Section 7.2.10 are presented in this document at the end of the section.

Semivolatile organics (also known as base/neutral and acid extractables) in water and soil samples are analyzed using method SW8270C. This technique determines quantitatively the concentration of a number of SVOCs. Samples are extracted and both base/neutral and acid extracts are then concentrated through evaporation. Compounds of interest are separated and quantified using a capillary column GC/mass spectrometer. The RLs are listed in Table 7.2.10-1.

The mass spectrometer is tuned every 12 hours to give an acceptable spectrum for decafluorotriphenylphosphine (DFTPP). The tuning acceptance criteria are given in the following list as an ion abundance for each specified mass:

- mass 51 30 percent to 60 percent of mass 198
- mass 68 less than 2 percent of mass 69
- mass 70 less than 2 percent of mass 69
- mass 127 40 percent to 60 percent of mass 198
- mass 197 less than 1 percent of mass 198
- mass 198 base peak, 100 percent relative abundance
- mass 199 5 percent to 9 percent of mass 198
- mass 275 10 percent to 30 percent of mass 198
- mass 365 greater than 1 percent of mass 198
- mass 441 present, but less than mass 443
- mass 442 greater than 40 percent of mass 198
- mass 443 17 percent to 23 percent of mass 442

The IS method is used for quantitation of analytes of interest. For quantitation, RFs are calculated from the base ion peak of a specific IS that is added to each calibration standard, blank, QC sample, and sample. The calibration, QC, corrective action, and data flagging requirements are given in Tables 7.2.10-2 and 7.2.10-3.

Table 7.2.10-1. RLs for Method SW8270C

Parameter/Method	Analyte	Water		Soil	
		RL	Unit	RL	Unit
Semivolatile organics Base/Neutral Extractables SW8270C	1,2,4-Trichlorobenzene	10.0	µg/L	0.7	mg/kg
	1,2-DCB	10.0	µg/L	0.7	mg/kg
	1,3-DCB	10.0	µg/L	0.7	mg/kg
	1,4-DCB	10.0	µg/L	0.7	mg/kg
	2,4-DNT	10.0	µg/L	0.7	mg/kg
	2,6-DNT	10.0	µg/L	0.7	mg/kg
	2-Chloronaphthalene	10.0	µg/L	0.7	mg/kg
	2-Methylnaphthalene	10.0	µg/L	0.7	mg/kg
	2-Nitroaniline	50.0	µg/L	3.3	mg/kg
	3-Nitroaniline	50.0	µg/L	3.3	mg/kg
	3,3'-Dichlorobenzidine	20.0	µg/L	1.3	mg/kg
	4-Bromophenyl phenyl ether	10.0	µg/L	0.7	mg/kg
	4-Chloroaniline	20.0	µg/L	1.3	mg/kg
	4-Chlorophenyl phenyl ether	10.0	µg/L	0.7	mg/kg
	4-Nitroaniline	50.0	µg/L	3.3	mg/kg
	Acenaphthylene	10.0	µg/L	0.7	mg/kg
	Acenaphthene	10.0	µg/L	0.7	mg/kg
	Anthracene	10.0	µg/L	0.7	mg/kg
	Benz (a) anthracene	10.0	µg/L	0.7	mg/kg
	Benzo (a) pyrene	10.0	µg/L	0.7	mg/kg
	Benzo (b) fluoranthene	10.0	µg/L	0.7	mg/kg
	Benzo (g,h,i) perylene	10.0	µg/L	0.7	mg/kg
	Benzyl alcohol	20.0	µg/L	1.3	mg/kg
	Bis (2-chloroethoxy) methane	10.0	µg/L	0.7	mg/kg
	Bis (2-chlorethyl) ether	10.0	µg/L	0.7	mg/kg
	Bis (2-chloroisopropyl) ether	10.0	µg/L	0.7	mg/kg
	Bis (2-ethylhexyl) phthalate	10.0	µg/L	0.7	mg/kg
	Butyl benzylphthalate	10.0	µg/L	0.7	mg/kg
	Chrysene	10.0	µg/L	0.7	mg/kg
	Di-n-butylphthalate	10.0	µg/L	0.7	mg/kg
	Di-n-octylphthalate	10.0	µg/L	0.7	mg/kg
	Dibenz (a,h) anthracene	10.0	µg/L	0.7	mg/kg
	Dibenzofuran	10.0	µg/L	0.7	mg/kg
	Diethyl phthalate	10.0	µg/L	0.7	mg/kg
	Dimethyl phthalate	10.0	µg/L	0.7	mg/kg
	Fluoranthene	10.0	µg/L	0.7	mg/kg
	Fluorene	10.0	µg/L	0.7	mg/kg
	Hexachlorobenzene	10.0	µg/L	0.7	mg/kg
	Hexachlorobutadiene	10.0	µg/L	0.7	mg/kg
	Hexachlorocyclopentadiene	10.0	µg/L	0.7	mg/kg
	Hexachloroethane	10.0	µg/L	0.7	mg/kg
	Indeno (1,2,3-cd) pyrene	10.0	µg/L	0.7	mg/kg
	Isophorone	10.0	µg/L	0.7	mg/kg
	n-Nitrosodiphenylamine	10.0	µg/L	0.7	mg/kg
	n-Nitrosodi-n-propylamine	10.0	µg/L	0.7	mg/kg
	Naphthalene	10.0	µg/L	0.7	mg/kg
	Nitrobenzene	10.0	µg/L	0.7	mg/kg
	Phenanthrene	10.0	µg/L	0.7	mg/kg
	Pyrene	10.0	µg/L	0.7	mg/kg

Table 7.2.10-1. Concluded

Parameter/Method	Analyte	Water		Soil	
		RL	Unit	RL	Unit
Semivolatile organics Acid Extractables SW8270C	2,4,5-Trichlorophenol	50.0	µg/L	3.3	mg/kg
	2,4,6-Trichlorophenol	10.0	µg/L	0.3	mg/kg
	2,4-Dichlorophenol	10.0	µg/L	0.3	mg/kg
	2,4-Dimethylphenol	10.0	µg/L	0.3	mg/kg
	2,4-Dinitrophenol	50.0	µg/L	3.3	mg/kg
	2-Chlorophenol	10.0	µg/L	0.3	mg/kg
	2-Methylphenol	10.0	µg/L	0.3	mg/kg
	2-Nitrophenol	10.0	µg/L	0.3	mg/kg
	4,6-Dinitro-2-methylphenol	50.0	µg/L	3.3	mg/kg
	4-Chloro-3-methylphenol	20.0	µg/L	1.3	mg/kg
	4-Methylphenol	10.0	µg/L	0.3	mg/kg
	4-Nitrophenol	50.0	µg/L	1.6	mg/kg
	Benzoic acid	50.0	µg/L	1.6	mg/kg
	Pentachlorophenol	50.0	µg/L	3.3	mg/kg
	Phenol	10.0	µg/L	0.3	mg/kg

Table 7.2.10-2. QC Acceptance Criteria for Method SW8270C

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)	Assoc. IS	Assoc. Sur.
SW8270C	1,2,4-Trichlorobenzene	44-142	≤ 20	34-152	≤ 30	2	4
	1,2-DCB	42-155	≤ 20	32-135	≤ 30	1	3
	1,3-DCB	36-125	≤ 20	26-135	≤ 30	1	3
	1,4-DCB	30-125	≤ 20	25-135	≤ 30	1	3
	2,4-DNT	39-139	≤ 20	29-149	≤ 30	3	4
	2,6-DNT	51-125	≤ 20	41-135	≤ 30	3	4
	2-Chloronaphthalene	60-125	≤ 20	50-135	≤ 30	3	4
	2-Methylnaphthalene	41-125	≤ 20	31-135	≤ 30	2	5
	2-Nitroaniline	50-125	≤ 20	40-135	≤ 30	3	2
	3,3'-Dichlorobenzidine	29-175	≤ 20	25-175	≤ 30	5	6
	3-Nitroaniline	51-125	≤ 20	41-135	≤ 30	3	2
	4-Bromophenyl phenyl ether	53-127	≤ 20	43-137	≤ 30	4	1
	4-Chloroaniline	45-136	≤ 20	35-146	≤ 30	2	5
	4-Chlorophenyl phenyl ether	51-132	≤ 20	41-142	≤ 30	3	4
	4-Nitroaniline	40-143	≤ 20	30-153	≤ 30	3	2
	Acenaphthylene	47-125	≤ 20	37-135	≤ 30	3	4
	Acenaphthene	49-125	≤ 20	39-135	≤ 30	3	4
	Anthracene	45-165	≤ 20	35-175	≤ 30	4	1
	Benz (a) anthracene	51-133	≤ 20	41-143	≤ 30	5	6
	Benzo (a) pyrene	41-125	≤ 20	31-135	≤ 30	6	6
	Benzo (b) fluoranthene	37-125	≤ 20	27-135	≤ 30	6	6
	Benzo (g,h,i) perylene	34-149	≤ 20	25-159	≤ 30	6	6
	Benzyl alcohol	35-125	≤ 20	25-135	≤ 30	1	3
	Bis (2-chloroethoxy) methane	49-125	≤ 20	39-135	≤ 30	2	5
	Bis (2-chloroethyl) ether	44-125	≤ 20	34-135	≤ 30	1	3
	Bis (2-chloroisopropyl) ether	36-166	≤ 20	26-175	≤ 30	1	3
	Bis (2-ethylhexyl) phthalate	33-129	≤ 20	25-139	≤ 30	5	6
	Butyl benzyl phthalate	26-125	≤ 20	25-135	≤ 30	5	6

Table 7.2.10-2. Concluded

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)	Number	
	Chrysene	55-133	≤ 20	45-143	≤ 30	5	6
	Di-n-butyl phthalate	34-126	≤ 20	25-136	≤ 30	4	1
	Di-n-octyl phthalate	38-127	≤ 20	28-137	≤ 30	5	6
	Dibenz (a,h) anthracene	50-125	≤ 20	40-135	≤ 30	6	6
	Dibenzofuran	52-125	≤ 20	42-135	≤ 30	3	4
	Diethyl phthalate	37-125	≤ 20	27-135	≤ 30	3	4
	Dimethyl phthalate	25-175	≤ 20	25-175	≤ 30	3	4
	Fluoranthene	47-125	≤ 20	37-135	≤ 30	4	1
	Fluorene	48-139	≤ 20	38-149	≤ 30	3	2
	Hexachlorobenzene	46-133	≤ 20	36-143	≤ 30	4	1
	Hexachlorobutadiene	25-125	≤ 20	25-135	≤ 30	2	5
	Hexachlorocyclopentadiene	41-125	≤ 20	31-135	≤ 30	3	2
	Hexachloroethane	25-153	≤ 20	25-163	≤ 30	1	3
	Indeno (1,2,3-c,d) pyrene	27-160	≤ 20	25-170	≤ 30	5	6
	Isophorone	26-175	≤ 20	25-175	≤ 30	2	5
	n-Nitrosodi-n-propylamine	37-125	≤ 20	27-135	≤ 30	1	3
	n-Nitrosodiphenylamine	27-125	≤ 20	25-135	≤ 30	4	1
	Naphthalene	50-125	≤ 20	40-135	≤ 30	2	5
	Nitrobenzene	46-133	≤ 20	36-143	≤ 30	2	4
	Phenanthrene	54-125	≤ 20	44-135	≤ 30	4	1
	Pyrene	47-136	≤ 20	37-146	≤ 30	5	6
	2,4,5-Trichlorophenol	25-175	≤ 20	25-175	≤ 30	3	1
	2,4,6-Trichlorophenol	39-128	≤ 20	29-138	≤ 30	3	1
	2,4-Dichlorophenol	46-125	≤ 20	36-135	≤ 30	2	5
	2,4-Dimethylphenol	45-139	≤ 20	35-149	≤ 30	2	5
	2,4-Dinitrophenol	30-151	≤ 20	25-161	≤ 30	3	4
	2-Chlorophenol	41-125	≤ 20	31-135	≤ 30	1	3
	2-Methylphenol	25-125	≤ 20	25-135	≤ 30	1	3
	2-Nitrophenol	44-125	≤ 20	34-135	≤ 30	2	4
	4,6-Dinitro-2-Methyl Phenol	26-134	≤ 20	25-144	≤ 30	4	1
	4-Chloro-3-Methyl Phenol	44-125	≤ 20	34-135	≤ 30	2	5
	4-Methylphenol	33-125	≤ 20	25-135	≤ 30	1	3
	4-Nitrophenol	25-131	≤ 20	25-141	≤ 30	3	2
	Benzoic Acid	25-162	≤ 20	25-172	≤ 30	2	5
	Pentachlorophenol	28-136	≤ 20	38-146	≤ 30	4	1
	Phenol	25-125	≤ 20	25-135	≤ 30	1	5
	Surrogates:						
	2,4,6-Tribromophenol	25-134		25-144		1	
	2-Fluorobiphenyl	43-125		34-135		2	
	2-Fluorophenol	25-125		25-135		3	
	Nitrobenzene-D5	32-125		25-135		4	
	Phenol-D5	25-125		25-135		5	
	Terphenyl-D14	42-126		32-136		6	
	Internal Standards:						
	1,4-Dichlorobenzene-D4					1	
	Naphthalene-D8					2	
	Acenaphthalene-D8					3	
	Phenanthrene-D10					4	
	Chrysene-D12					5	
	Perylene-D12					6	

Table 7.2.10-3. Summary of Calibration and QC Procedures for Method SW8270C

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^a	Flagging Criteria ^b
SW8270C	Semi-Volatile Organics	Five-point initial calibration for all analytes	Initial calibration prior to sample analysis	SPCCs average RF ≥ 0.050 and %RSD for RFs for CCCs $\leq 30\%$ and one option below	Correct problem then repeat initial calibration	Apply R to all results for all samples associated with the calibration
				option 1 linear-mean RSD for all analytes $\leq 15\%$ with no individual analyte RSD $> 30\%$		Apply R to all results for specific analyte(s) for all samples associated with the calibration
				option 2 linear - least squares regression $r > 0.995$		
				option 3 non-linear - COD ≥ 0.990 (6 points shall be used for second order, 7 points shall be used for third order)		
		Second-source calibration verification	Once per five-point initial calibration	All analytes within $\pm 25\%$ of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Retention time window calculated for each analyte	Each sample	Relative retention time (RRT) of the analyte within ± 0.06 RRT units of the RRT	Correct problem then reanalyze all samples analyzed since the last retention time check	Apply R to all results for the specific analyte(s) in the sample
SW8270C	Semi-Volatile Organics	Calibration verification	Daily, before sample analysis and every 12 hours of analysis time	SPCCs average RF ≥ 0.050 ; and CCCs $\leq 20\%$ difference (when using RFs) or drift (when using least squares regression or non-linear calibration)	Correct problem then repeat initial calibration	Apply R to all results for all samples associated with the calibration verification
				All calibration analytes within $\pm 20\%$ of expected value		Apply R to all results for specific analyte(s) for all samples associated with the calibration verification

Table 7.2.10-3. Continued

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^a	Flagging Criteria ^b
SW8270C	Semi-Volatile Organics	Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table 7.2.10-2	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria	Apply R to all results for all samples analyzed by the analyst
		ISS	Immediately after or during data acquisition for each sample	Retention time ± 30 seconds from retention time of the mid-point std. in the ICAL. BICP area within -50% to +100% of ICAL mid-point std.	Inspect mass spectrometer and GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning	Apply R to all results for analytes associated with the IS
		Method blank	One per analytical batch	No analytes detected \geq RL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank	Apply B to all results for the specific analyte(s) in all samples in the associated analytical batch
		LCS for all analytes	One LCS per analytical batch	QC acceptance criteria, Table 7.2.10-2	Correct problem then reprep and analyze the LCS and all samples in the affected AFCEE analytical batch	For specific analyte(s) in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects
		MS/MSD	One MS/MSD per every 20 Air Force project samples per matrix	QC acceptance criteria, Table 7.2.10-2	none	For the specific analyte(s) in all samples collected from the same site matrix as the parent, apply M if; (1) %R for MS or MSD > UCL or (2) %R for MS or MSD < LCL or (3) MS/MSD RPD > CL

Table 7.2.10-3. Concluded

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^a	Flagging Criteria ^b
SW8270C	Semi-Volatile Organics	Check of mass spectral ion intensities using DFTPP	Prior to initial calibration and calibration verification	Refer to criteria listed in the method description (section 7.2.10)	Retune instrument and verify	Apply R to all results for all samples associated with the tune
		Surrogate spike	Every sample, spiked sample, standard, and method blank	QC acceptance criteria, Table 7.2.10-2	Correct problem then reextract and analyze sample	For the samples; if the %R > UCL for a surrogate, apply J to all positive results of analytes associated with the surrogate if the %R < LCL for a surrogate, apply J to all positive results of analytes associated with the surrogate, apply R to all non-detect results of analytes associated with the surrogate If any surrogate recovery is < 10%, apply R to all results of analytes associated with the surrogate
		MDL study	Once per 12 month period	Detection limits established shall be $\leq \frac{1}{2}$ the RLs in Table 7.2.10-1	none	Apply R to all results for the specific analyte(s) in all samples analyzed
		Results reported between MDL and RL	none	None	none	Apply F to all results between MDL and RL

a. All corrective actions associated with AFCEE project work shall be documented, and all records shall be maintained by the laboratory.

b. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.

Requirements for Containers, Preservation Techniques, Sample Volumes, and Holding Times

Name	Analytical Methods	Container	Preservation	Minimum Sample Volume or Weight	Maximum Holding Time
Semivolatile Organics	SW8270C	G, Teflon-lined cap, T	4°C	1 liter or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)

Notes:

G glass

T stainless steel sleeves in the sample barrel

STL Los Angeles Proposed RL's and QC Limits for 8270C - Tables 7.2.10-1 and 7.2.10-2 of the AFCOE QAPP

8270 Constituent	Water			Soil		
	Proposed QC limit (%R)	Proposed RPD (%)	Proposed RL (µg/L)	Proposed QC limit (%R)	Proposed RPD (%)	Proposed RL (mg/kg)
Acenaphthene	50-100	≤ 30	10.0	50-130	≤ 35	0.330
Acenaphthylene			10.0			0.330
Anthracene			10.0			0.330
Benzo(a)anthracene			10.0			0.330
Benzo(b)fluoranthene			10.0			0.330
Benzo(k)fluoranthene			10.0			0.330
Benzoic Acid			50.0			1.600
Benzo(ghi)perylene			10.0			0.330
Benzo(a)pyrene			10.0			0.330
Benzyl alcohol			10.0			0.330
Bis(2-chloroethoxy)methane			10.0			0.330
Bis(2-chloroethyl)ether			10.0			0.330
Bis(2-chloroisopropyl)ether			10.0			0.330
Bis(2-ethylhexyl)phthalate			10.0			0.330
4-bromophenyl phenyl ether			10.0			0.330
Butyl benzyl phthalate			10.0			0.330
4-Chloroaniline			10.0			0.660
4-chloro-3-methylphenol	45-95	≤ 30	10.0	50-120	≤ 35	0.330
2-chloronaphthalene			10.0			0.330
2-Chlorophenol	45-95	≤ 30	10.0	45-125	≤ 35	0.330
4-chlorophenyl phenyl ether			10.0			0.330
Chrysene			10.0			0.330
Dibenzo(a,h)anthracene			10.0			0.330
Dibenzofuran			10.0			0.330
Di-n-butyl phthalate			10.0			0.330
1,2-Dichlorobenzene			10.0			0.330
1,3-Dichlorobenzene			10.0			0.330
1,4-Dichlorobenzene	35- 95	≤ 30	10.0	35-115	≤ 35	0.330
3,3-Dichlorobenzidine			50.0			1.600
2,4-Dichlorophenol			10.0			0.330

**STL Los Angeles Proposed RL's and QC Limits for 8270C - Tables 7.2.10-1 and 7.2.10-2 of the AFCEE
QAPP. Concluded**

8270 Constituent	Proposed QC limit (%R)	Proposed RPD (%)	Proposed RL (µg/L)	Proposed QC limit (%R)	Proposed RPD (%)	Proposed RL (mg/kg)
Diethyl phthalate			10.0			0.330
2,4-Dimethylphenol			10.0			0.330
Dimethyl phthalate			10.0			0.330
4,6-Dinitro-2-methylphenol			50.0			1.600
2,4-Dinitrophenol			50.0			1.600
2,4-Dinitrotoluene	50-115	≤ 30	10.0	40-125	≤ 35	0.330
2,6-Dinitrotoluene			10.0			0.330
Di-n-octyl phthalate			10.0			0.330
Fluoranthene			10.0			0.330
Fluorene			10.0			0.330
Hexachlorobenzene			10.0			0.330
Hexachlorobutadiene			10.0			0.330
Hexachlorocyclopentadiene			50.0			1.600
Hexachloroethane			10.0			0.330
Indeno(123cd)pyrene			10.0			0.330
Isophorone			10.0			0.330
2-methylnaphthalene			10.0			0.330
2-methylphenol			10.0			0.330
3&4-methylphenol			10.0			0.330
Naphthalene			10.0			0.330
2-Nitroaniline			50.0			1.600
3-Nitroaniline			50.0			1.600
4-Nitroaniline			50.0			1.600
Nitrobenzee			10.0			0.330
2-Nitrophenol			10.0			0.330
4-Nitrophenol	10-50	≤ 30	50.0	10-120	≤ 35	1.600
N-Nitrosodiphenylamine			10.0			0.330
N-Nitrosodi-n-propylamine	40-110	≤ 30	10.0	40-125	≤ 35	0.330
Pentachlorophenol	40-110	≤ 30	50.0	20-130	≤ 35	1.600
Phenanthrene			10.0			0.330
Phenol	10-50	≤ 30	10.0	40-110	≤ 35	0.330
Pyrene	50-120	≤ 30	10.0	50-145	≤ 35	0.330
1,2,4-Trichlorobenzene	35-105	≤ 30	10.0	50-120	≤ 35	0.330
2,4,5-Trichlorophenol			10.0			0.330
2,4,6-Trichlorophenol			10.0			0.330
Surrogates						
2-Fluorobiphenyl	45-110			35-140		
2-Fluorophenol	10-75			35-125		
2,4,6-Tribromophenol	30-125			25-135		
Nitrobenzene-d5	40-110			35-130		
Phenol-d5	10-60			35-130		
Terphenyl-d14	34-125			35-150		

- RL Justification: Hexachloropentadiene and 3,3-Dichlorobenzidene (non-critical compounds) have RL's above those stated in the AFCEE QAPP. Examination of the raw data for standards containing these compounds at or slightly below the AFCEE RL demonstrates that the chromatography is not reliable at these levels. Proposed RL's are elevated to ensure that the RL is at least a factor of two greater than the most recently established laboratory MDL, as required by Section 4.3.2 of the AFCEE QAPP, and to ensure that the laboratory is able to meet the AFCEE calibration linearity requirements. All other RL's are at or below the AFCEE defined values.
- QC Justification: The proposed acceptance limits are based on the laboratories' historical data calculated as specified in SW-846, i.e., three standard deviations. Four controlled analytes have QC limits wider than those defined in the AFCEE QAPP – 4-Nitrophenol in water and soil, Phenol in water, Pentachlorophenol in soil and 1,2,4-Trichlorobenzene in water. All other QC limits have narrower acceptance ranges. All controlled analytes have RPD's wider than those defined in the AFCEE QAPP. Surrogate QC limits are narrower except for Phenol-d5 and Terphenyl-d14 in water and 2-Fluorobiphenyl, 2-Fluorophenol and Terphenyl-d14 in soil.

8270C ICAL & CCV Variances - Table 7.2.10-3 of the AFCEE QAPP

- Requirement: ICAL criterion for all analytes - mean RSD for all analytes $\leq 15\%$ with no individual analyte RSD $>30\%$; (2) first order regression, $r, \geq 0.995$; or (3) non-linear, COD ≥ 0.990 . Calibration verification (CCV) results for all analytes must be within $\pm 20\%$ of expected value.
- Proposed: SPCC average RF ≥ 0.050 with the % RSD for CCC's $\leq 30\%$ and the mean %RSD for all analytes $\leq 15\%$. CCV criteria – Average RF 0.050 for the SPCC's and %D $\leq 20\%$ for the CCC's.
- Justification: Upon receipt of samples for this project there was no guidance document available for the lab. The 8270 analysis was set up based upon STL Los Angeles' standard 8270 product. The compound list and subsequent RL's and QC Limits are based upon the Standard Product. Further continuity for this project will be maintained if based upon these limits.

Section 5.7.2.4

ICP Screen for Metals by SW6010B, Tables 5.7-12 and 5.7-13

Analytical Method	Analyte	Water			Soil		
		Proposed Accuracy (%R)	Proposed Precision (%)	Proposed RL mg/L	Proposed Accuracy (%R)	Proposed Precision (%)	Proposed RL mg/kg
SW6010B	Aluminum	80 - 120	≤ 20	0.2	70 - 115	≤ 25	20
	Antimony	80 - 120	≤ 20	0.06	75 - 115	≤ 25	6.0
	Arsenic	80 - 120	≤ 20	0.01	75 - 115	≤ 25	1.0
	Barium	80 - 120	≤ 20	0.02	80 - 120	≤ 25	2.0
	Beryllium	85 - 120	≤ 20	0.005	80 - 120	≤ 25	0.5
	Boron *	80 - 120	≤ 20	0.2	80 - 120	≤ 25	20
	Cadmium	80 - 120	≤ 20	0.005	80 - 120	≤ 25	0.5
	Calcium	80 - 120	≤ 20	5.0	80 - 120	≤ 25	500
	Chromium	85 - 120	≤ 20	0.01	85 - 120	≤ 25	1.0
	Cobalt	80 - 120	≤ 20	0.05	80 - 120	≤ 25	5.0
	Copper	80 - 120	≤ 20	0.025	80 - 120	≤ 25	2.5
	Iron	85 - 125	≤ 20	0.1	85 - 125	≤ 25	10
	Lead	80 - 120	≤ 20	0.005	80 - 120	≤ 25	0.5
	Magnesium	80 - 120	≤ 20	5.0	80 - 120	≤ 25	500
	Manganese	85 - 120	≤ 20	0.015	85 - 120	≤ 25	1.5
	Molybdenum	80 - 120	≤ 20	0.04	80 - 120	≤ 25	4.0
	Nickel	80 - 120	≤ 20	0.04	80 - 120	≤ 25	4.0
	Potassium	80 - 120	≤ 20	5.0	80 - 120	≤ 25	500
	Selenium	80 - 120	≤ 20	0.005	70 - 115	≤ 25	0.5
	Silicon *	80 - 120	≤ 20	0.5	----	----	----
	Silver	80 - 120	≤ 20	0.01	80 - 120	≤ 25	1.0
	Sodium	80 - 120	≤ 20	5.0	80 - 120	≤ 25	500
	Strontium *	80 - 120	≤ 20	0.05	80 - 120	≤ 25	5.0
	Thallium	75 - 125	≤ 20	0.01	75 - 125	≤ 25	1.0

Section 5.7.2.4

ICP Screen for Metals by SW6010B, Tables 5.7-12 and 5.7-13. Concluded

Analytical Method	Analyte	Water			Soil		
		Proposed Accuracy (%R)	Proposed Precision (%)	Proposed RL mg/L	Proposed Accuracy (%R)	Proposed Precision (%)	Proposed RL mg/kg
	Tin *	80 – 120	≤20	0.1	80 – 120	≤25	10.0
SW6010B concluded	Titanium *	80 – 120	≤20	0.05	80 – 120	≤25	5.0
	Vanadium	85 – 120	≤20	0.05	80 – 120	≤25	5.0
	Zinc	85 - 120	≤20	0.02	80 – 120	≤25	2.0

* - Not in the March ARB QAPP but analyzed and reported by STL Los Angeles when requested

Requirement: Meet the 6010 Reporting, Accuracy and Precision Limits as stated in the MARCH QAPP, Tables 5.7-12 and 5.7-13.

Proposed: The laboratory proposes to use the RL's and QC Limits as stated in the above table.

RL Justification: MDL data supports the higher RL's for both soil and water.

QC Justification: All QC limits are equal to or tighter than those stated in the March QAPP except for Aluminum and Selenium, which have wider limits - 70-115. The RPD's for Water meet the QAPP Limits. Historical data supports the QC Limits listed in the above table.

Requirement: The RPD requirement for Soil is ≤ 20% in the March ARB QAPP.

Proposed: The RPD be raised to ≤ 25%.

QC Justification: Historical QC data supports the larger RPD limit.

Table 5.7-14 – Method 6010B Calibration and QC Criteria

Requirement: The Interference Check Solution is to be analyzed at the beginning and the end of an analytical sequence.

Proposed: Delete the requirement for the ICS to be analyzed at the end of the sequence.

Justification: SW6010B states that the ICS is to be run at the beginning of the analytical sequence.

Requirement: With each new sample matrix perform a Dilution Test. Corrective Action for an RPD of ≥ 10% is a Post Digestion Spike.

Proposed: Delete the requirement for the Post Digestion Spike.

Justification: Post Digestion Spikes are used to measure matrix interference. The LCS and MS/MSD's that are routinely performed with each batch allow for the determination of matrix interference within both the preparation batch and the analytical batch.

Analytical Method	Analyte	Water			Soil		
		Proposed Accuracy (%R)	Proposed Precision (%)	Proposed RL (mg/L)	Proposed Accuracy (%R)	Proposed Precision (%)	Proposed RL (mg/kg)
SW7470A / SW7471A	Mercury	80 – 120	≤ 20	0.0002	85 – 115	≤ 20	0.1

Requirement: The RL for water is listed at 0.001 mg/L, the Accuracy limits for both soil and water are listed at 77 – 120 and the RPD limit for soil is listed at ≤ 25% in the March ARB QAPP.

Proposed: The laboratory proposes to use 0.0002 as the RL for water, accuracy limits of 80-120 for water, 85-115 for soils, and an RPD of ≤ 20% for soil. Accuracy limits for MS/MSD for soil would be 80-120.

Justification: MDL data supports the lower RL and historical QC data supports the tighter QC limits.

Requirement: The RPD requirement for Water is ≤ 15% in the March ARB QAPP.

Proposed: The RPD be raised to ≤ 20%.

Justification: Historical QC data supports the larger RPD limit.

Requirement: A Five-fold Dilution test be performed for each preparation batch.

Proposed: Delete the requirement.

Justification: This dilution is not mandated in SW7470A and SW7471A. SW7471A makes reference to section 8 in SW846 Method 7000. Section 8 states that, “For each analytical batch select one typical sample... The concentration of the analyte should be at least 25 times the estimated detection limit.” Very rarely are there samples that have Mercury levels that meet the required concentrations to perform the Dilution Test. The LCS and MS/MSD’s that are routinely performed with each batch allow for the determination of matrix interference within both the preparation batch and the analytical batch.

Requirement: A Recovery Test be performed when the Five-fold Dilution test fails.

Proposed: Delete the requirement

Justification: The concept becomes null when the Five-fold Dilution test is deleted.

Section 5.7.2.7

Method TO-14 Volatile Organics in Ambient Air

A full analyte list will be reported for this method instead of the abbreviated list in the QAPP for March ARB. Reporting limits are lower than those specified in the AFCEE QAPP and are presented in Table A5.7-21 which supercedes Table 5.7-21. Results will be reported in part per billion/volume (ppbv) units, instead of $\mu\text{g/L}$.

The laboratory will control five target analytes using acceptance criteria gathered from historical data. The five target analytes, including the acceptance criteria, are specified in Table A5.7-22 which supercedes Table 5.7-22.

Table A5.7-21. Reporting Limits for Method TO-14

Parameter	Method A=Air	Analyte	Air (ppb v/v) ⁽¹⁾
Volatile Organic Compounds in Air	TO-14	Dichlorodifluoromethane (Freon 12)	2.0
		Chloromethane	4.0
		1,2,-dichloro-1,1,2,2-tetrafluoroethane (Freon 114)	2.0
		Vinyl chloride	2.0
		Bromomethane	2.0
		Chloroethane	4.0
		Trichlorofluoromethane (Freon 11)	2.0
		Cis-1,2-dichloroethene	2.0
		Carbon disulfide	10.0
		1,1,2-trichloro-1,2,2-trifluoroethane (Freon 113)	2.0
		Acetone	10.0
		Methylene chloride	2.0
		Trans-1,2-dichloroethene	2.0
		1,1-dichloroethane	2.0
		Vinyl acetate	10.0
		1,1-dichloroethene	2.0
		2-butanone	10.0
		Chloroform	2.0
		1,1,1-trichloroethane	2.0
		Carbon tetrachloride	2.0
		Benzene	2.0
		1,2-dichloroethane	2.0
		Trichloroethene	2.0
		1,2-dichloropropane	2.0
		Bromodichloromethane	2.0
		Cis-1,3-dichloropropene	2.0
		4-Methyl-2-pentanone	10.0
		Toluene	2.0
		Trans-1,3-dichloropropene	2.0
		1,1,2-trichloroethane	2.0
		Tetrachloroethene	2.0
		2-hexanone	10.0
		Dibromochloromethane	2.0
		1,2-dibromoethane	2.0
		Chlorobenzene	2.0
		Ethylbenzene	2.0
		p,m-xylenes	2.0
		o-xylene	2.0
		Styrene	2.0

Table A5.7-21. Concluded

Parameter	Method A=Air	Analyte	Air (ppb v/v) ⁽¹⁾
Volatile Organic Compounds in Air (concluded)		Bromoform	2.0
		1,1,2,2-tetrachloroethane	2.0
		Benzyl chloride	10.0
		4-ethyl toluene	2.0
		1,3,5-trimethylbenzene	2.0
		1,2,4-trimethylbenzene	2.0
		1,3-dichlorobenzene	2.0
		1,4-dichlorobenzene	2.0
		1,2-dichlorobenzene	2.0
		1,2,4-trichlorobenzene	5.0
		Hexachlorobutadiene	4.0
		MTBE	2.0

(1) Reporting limits based on sample prior to Summa canister pressurization.

Table A5.7-22. QC Acceptance Criteria for Method TO-14

Method	Analyte	Accuracy (%R)	Precision (%RPD)
TO-14	1,1,2,2-Tetrachloroethane	70–130	≤20
	1,1-Dichloroethene	70–125	≤20
	Toluene	70–120	≤20
	Methylenechloride	75–120	≤20
	Trichloroethene	80–125	≤20

Section 5.7.2.8

Petroleum Hydrocarbons by 8015 Modified, Tables 5.7-24 and 5.7-25

Analytical Method	Analyte	Water			Soil		
		Proposed Accuracy (%R)	Proposed Precision (%)	Proposed RL (mg/L)	Proposed Accuracy (%R)	Proposed Precision (%)	Proposed RL (mg/kg)
SW8015 Mod GRO	TPH-Gasoline	70 –140	≤ 25	0.1	70 –140	≤ 40	1.0
	Surrogate: a,a,a-tri-fluorotoluene	60 -130			60 -130		
SW8015 Mod DRO	TPH-Diesel	65 –140	≤ 25	1.0	60 –130	≤ 35	10.0
	*TPH-Jet Fuel – (JP-4) (JP-8 only when specifically requested)	65 -140	≤ 25	1.0	60 –130	≤ 35	10.0
	Surrogate: Benzo(a)pyrene	60 -130			60 -130		

*JP-4 and JP-8 precision and accuracy to be controlled by Diesel

TPH – Gas (Med. Level) –

Analytical Method	Analyte	Accuracy % R Med level Soil (mg/kg)	Precision % Med level Soil (mg/kg)	R.L. Med level Soil (mg/kg)
8015 Mod - GRO Medium Level	TPH-Gasoline	80 – 140	≤ 40%	10
	Surrogate: a,a,a-trifluorotoluene	75 - 135		

Requirement: Chlorobenzene is listed as the surrogate compound for gasoline analysis (GRO).
Proposed: The laboratory proposes to use a,a,a-trifluorotoluene as the GRO surrogate.
Justification: GRO analysis using an FID detector (8015) is often run in conjunction with analysis for volatile aromatics using a PID detector (8021). The laboratory does not use chlorobenzene as a surrogate because the compound is an EPA regulated target analyte for volatile aromatic analysis.

Requirement: A choice of two surrogates out of the four that are listed for Diesel Analysis (DRO).
Proposed: The laboratory proposes to use only Benzo(a)Pyrene as the DRO surrogate.
Justification: This surrogate elutes at the tail end of the diesel range making for easier quantitation due to a decrease in potential matrix interference.

- Requirement:** The Accuracy limits for Gasoline in water and soil are 67-136 and 57-146 and the RPD's at 30 and 50 respectively in the March ARB QAPP. The Accuracy limits for the Surrogate in water and soil are 74-138 and 64-148 respectively in the March ARB QAPP. The Accuracy limits for Diesel in water and soil are 61-143 and 51-153 and the RPD's at 30 and 50 respectively in the March ARB QAPP. The Accuracy limits for Jet Fuel in water and soil are 61-143 and 51-153 and the RPD's at 30 and 50 respectively in the March ARB QAPP.
- Proposed:** Implement the Precision and Accuracy Limits as stated in tables 5.7-24 and 5.7-25.
- Justification:** Historical QC data supports the tighter QC limits.

Method TO-3 - Total Volatile Petroleum Hydrocarbons and BTEX in Air

Total volatile petroleum hydrocarbons and volatile aromatic hydrocarbons (benzene, toluene, ethylbenzene, and xylenes) in air samples collected in Summa Canisters or Tedlar bags will be analyzed using a GC with a capillary column and a PID and FID in series. The PID is used to detect the aromatic compounds while the FID is used to detect the hydrocarbons.

RLs for volatile TPH and BTEX are provided in Table A-1.

Identification and quantitation of TPH components require more analytical judgment than other GC methods. The TPH chromatograms consist of groups of peaks that fall within a noted carbon retention time range (i.e., number of carbon atoms in the molecule). Gasoline and BTEX components are used to calibrate the instruments. The total petroleum hydrocarbons results are reported in ppm (v/v) based on quantitation of the total area count for the gasoline range organics (i.e., C6-C10). The retention time window shall be set such that the window encompasses only the C6 through C10 range of organics. The calibration, QC, corrective action, and data flagging requirements are given in Tables A-2 and A-3. Second column confirmation is not required.

Requirements for Containers, Preservation Techniques, Sample Volumes, and Holding Times

Name	Analytical Methods	Container	Preservation	Minimum Sample Volume or Weight	Maximum Holding Time
Total Volatile Petroleum Hydrocarbons and BTEX	TO-3	SUMMA [®] canister	None	5000 mL	30 days
		Tedlar Bag	None	1000 mL	72 hours

Table A-1. RLs for Method TO-3

Parameter/Method	Analyte	Air	
		RL	Unit
Total Volatile Petroleum Hydrocarbons and BTEX (TO-3)	TVPH as Gasoline	1.0	ppm (v/v)
	Benzene	0.020	ppm (v/v)
	Toluene	0.020	ppm (v/v)
	Ethylbenzene	0.020	ppm (v/v)
	Total Xylenes	0.020	ppm (v/v)
	MTBE	0.020	ppm (v/v)

Table A-2. QC Acceptance Criteria for Method TO-3

Method	Analyte	Accuracy (% R)	Precision (% RPD)
TO-3	TVPH as Gasoline	85-125	≤ 20
	Benzene	70-130	≤ 20
	Toluene	70-130	≤ 20

Table A-3. Summary of Calibration and QC Procedures for Method TO-3

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^a	Flagging Criteria ^b
TO-3	Total Volatile Petroleum Hydrocarbons and BTEX	Five-point initial calibration for all analytes	Initial calibration prior to sample analysis	linear - mean RSD for all analytes ≤25% or linear - least squares regression $r > 0.995$	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Calibration verification	Daily, before sample analysis and at the end of the analysis sequence	All concentration levels within ±25% of initial calibration	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification	Apply R to all results for the specific analyte(s) in all samples since the last acceptable calibration verification
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table A-2	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria	Apply R to all results for all samples analyzed by the analyst
		Method blank	One per analytical batch	No TVPH detected ≥ RL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank	Apply B to all results for the specific analyte(s) in all samples in the associated analytical batch
		LCS for all analytes	One LCS per analytical batch	QC acceptance criteria, Table A-2	Correct problem then reprep and analyze the LCS and all samples in the affected AFCEE analytical batch	For specific analyte(s) in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects

Table A-3. Concluded

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^a	Flagging Criteria ^b
TO-3	Total Volatile Petroleum Hydrocarbons and BTEX	Retention time window calculated	Each initial calibration; additionally for BTEX when the LCS falls outside of RT windows	Calculate retention time from n-butane to n-dodecane and BTEX	Correct problem then reanalyze all samples analyzed since the last retention time check	Apply R to the result in the sample
		MDL study	Once per 12 month period	Detection limits established shall be $\leq \frac{1}{2}$ the RLs in Table A-1	none	Apply R to all results for the specific analyte(s) in all samples analyzed
		Results reported between MDL and RL	none	None	none	Apply F to all results between MDL and RL

- a. All corrective actions associated with AFCEE project work shall be documented, and all records shall be maintained by the laboratory.
- b. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.

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